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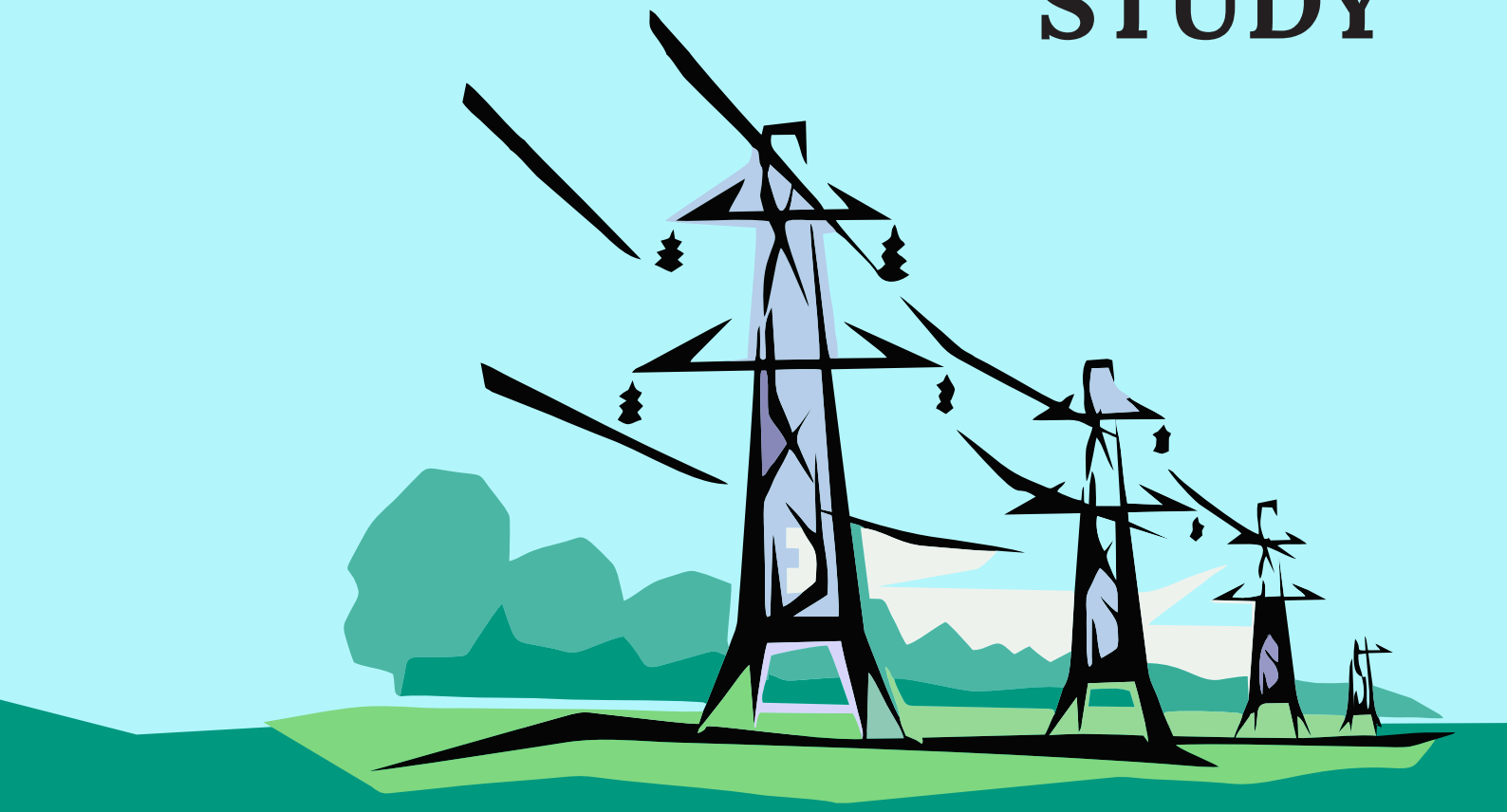
MERGED AREAS
ELECTRIFICATION STUDY



March
2021

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Acronyms	Abbreviations
ABC	Aerial Bundled Cables
ADB	Asian Development Bank
ADP	Annual Development Plan
AEDB	Alternate Energy Development Board
AIP	Accelerated Implementation Program
AKRSP	Agha Khan Rural Support Program
AMI	Automated Metering Infrastructure
AMR	Automated meter Reading System
BOD	Board of Directors
BPD	Barrels per Day
BPL	Below Poverty Line
CCI	Council of Common Interests
CCOE	Cabinet Committee on Energy
CDP	Common Delivery Points
CPPA	Central Power Purchasing Authority
DC	Direct Current
DFI	Development Finance Institute
DG	Director General
DGPC	Director General Petroleum Commission
DISCO	Distribution Company
ECC	Economic Coordination Committee
EE	Energy Efficiency
EEC	Energy Efficiency and Conservation
EMC	Energy Monitoring Cell
ERP	Enterprise Resource Planning
ESCO	Electricity Supply Company
ESMAP	Energy Sector Management Assistance Program
FATA	Federally Administered Tribal Areas
FBR	Federal Board of Revenue
FCR	Federal Crimes Regulation
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GENCO	Generation Company
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GOP	Government of Pakistan
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
HDF	Hydel Development Fund
HDI	Human Development Index
HPP	Hydro Power Project

IEA	International Energy Agency
IGTDP	Integrated Generation Transmission and Distribution Plan
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
JV	Joint Venture
KE	Karachi Electric
KP	Khyber Pakhtunkhwa
KPOGCL	Khyber Pakhtunkhwa Oil and Gas Company Limited
LPG	Liquified Petroleum Gas
LT	Low-Voltage Transmission
MA	Merged Areas
MAGP	Merged Areas Governance Project
MDTF	Mult-Donor Trust Fund
MMCFD	Million Cubic Feet per day
MOF	Ministry of Finance
MOL	MOL Plc
MTF	Multi-Tier Framework
NEA	Nepal Electric Authority
NEECA	National Energy Efficiency and Conservation Authority
NEPRA	National Electric Power Regulatory Authority
NFC	National Finance Commission
MAs	Merged Areas
NPCC	National Power Control Centre
NTDC	National Transmission and Despatch Company
OGDCL	Oil and Gas Development Company Limited
OGRA	Oil and Gas Regulatory Authority
OPM	Office of Prime Minister
PAEC	Pakistan Atomic Energy Commission
PBS	Pakistan Bureau of Statistics
PCA	Petroleum Concession Agreements
PD	Petroleum Division
PEDO	Pakhtunkhwa Energy Development Organization
PESCO	Peshawar Electric Supply Company
PIDE	Pakistan Institute of Development Economics
POL	Pakistan Oil Fields
PPI	Power Planner International
PPIB	Private Power Infrastructure Board
PPL	Pakistan Petroleum Limited
PPP	Power Purchase Price
PSC	Production Sharing Contracts
PSDP	Public Sector Sustainable Development Program

PSO	Pakistan State Oil
PTCL	Pakistan Telecommunications Company Limited
PV	Photo Voltaic Cell
PWC	Price Waterhouse Cooper
RE	Renewable Energy
REB	Rural Electrification Board
REST	Rural Electricity Supply Technology
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojana
RLCIP	Rural Livelihood and Community Infrastructure Project
RLNG	Re-liquified Natural Gas
SAPM	Special Assistant to the Prime Minister
SDO	Sub-Divisional Officers
SHS	Solar Home Systems
SHYDO	Sarhad Hydro Development Organization
SK	Suki Kinari Hydropower Project
SL	Sierra Leone
SME	Small and Medium Enterprises
SNGPL	Sui Northern Gas Pipeline Limited
SRO	Statuary Regulatory Orders
SSGCL	Sui Southern Gas Company Limited
TCF	Tonnes of Cubic Feet
TDS	Tariff Differential Subsidy
TESCO	Tribal Electric Supply Company
TOE	Tonnes of Oil Equivalent
TOR	Terms of Reference
TV	Television
TVE	Technical and Vocational Education
UNDP	United Nations Development Program
VCNC	Village Councils and Neighbourhood Councils
VRE	Variable Renewable Energy
WAPDA	Water and Power Development Authority
WBG	World Bank Group
XEN	Executive Engineer

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Executive Summary

01 Merged Areas (MAs) suffer from severe electricity shortages. With population of 5.5 million and a history of turmoil and conflicts, the electricity deficit is roughly estimated at around 600 MW. This has led to frequent load shedding up to 20-22 hours a day. The situation is worse off due to technical and grid challenges, which is being managed by the local distribution company, Tribal Electric Supply Company Organization (TESCO). Overall, TESCO grid provides electrification coverage of up to 57.3 percent at a village level with peak supply of 250 – 280 MW against an overall peak demand of 800 MW. The limited distribution and transmission network, coupled by an un-controlled demand, low investments in network upgradation and limited revenue generation capability have become major obstacles for an improved service delivery. Although, the number of electrified villages have increased during the past five years, there is little improvement in system reliability. For MAs, the domestic users are exempted to pay electricity bills, with Ministry of Finance (MOF) picking up an annual subsidy in the range of Rs. 18-20 billion per annum . Further, the access to grid for different agencies varies depending upon the distribution network. Out of all the districts, Khyber Agency is mostly electrified while the South Waziristan and Orakzai Agencies lags with only 25-50 percent of grid coverage.

02 Overall, TESCO's financial situation has become precarious. The chronic shortfall between cash inflows and outflows renders it completely reliant on the Federal Government support, mainly through subsidies. An ever-ballooning circular debt puts additional pressure for further network expansion. Shortages of inflows generally stem from three main factors: (i) There is no concept of cost recovery tariffs as domestic consumers (comprising of 93 percent of total consumer base) are exempt from paying electricity bills till FY2023, (ii) Federal Government fails or delays payment of Tariff Differential Subsidies (TDS) to TESCO; and (iii) Tariff determination and/or notification is delayed, so TESCO is caught between the actual costs for a period, the determined tariff for another, and the notified tariff for yet another one. In the entire scenario, weak fiscal situation results in sub-par operational capabilities, creating a spiral of impossibility scenario. This entire situation has dampened developmental prospects, particular for the disadvantaged. With limited electricity supply comes limited opportunities for education and healthcare. The situation has also poorly affected economic sectors, such as industrial and commercial ventures.

03 On the contrary, there is a strong evidence that off-grid methods, especially solar power has become ubiquitous in MAs, while some industrial and commercial facilities have also invested in back-up generators to keep functioning during load shedding hours. What we have witnessed through this diagnostic study is MAs wholehearted acceptability of distributive energy resources, especially the solar PV. Today, the area represents a community which is connected hundred percent on solar energy (the only exception is industrial consumers). Whether they are commercial markets, domestic consumers, hospitals or schools, nearly everyone is connected with solar power. Families, markets, hospitals and schools have adapted the technology at the heart of their every daily lives. Most of them are small-scale, ranging from 6KW to 10KW, distributed, designed for local social and ecological conditions, and owned and controlled for community wellbeing and resilience. The solar PV adaption has provided employment opportunities at the doorstep and so far, has come with a net-zero fiscal burden to the federal or provincial governments. It has ramped up willingness to pay for associated energy products (such as solar lights, DC fans etc.), has driven consumer demand and preserved well-being of local environment. Any concerted focus from the government can promote further resilience for energy justice, community participation and involvement in democratic politics in the long run.

04 Therefore, it is vital to rethink electrification strategy beyond TESCO's grid connected operations and to help erect a vibrant, fair, and an equitable market for distributive generation that can supplement grid electricity. The pace of progress can easily be accelerated through deployment of linear, non-expansive, solar based technologies, such as SHS and later, through mini-micro grids. One also must recognize that distributed resources, which have not appeared useful ten years ago can squarely address the needs of customers by providing best electricity services at the lowest cost and without burdening the fiscal budgets of the government. What we have learned from this diagnostic is that end users in MAs understand solar energy, knows the basics well enough to operate it, are willing to pay a premium for reliable electricity and have developed an on-ground mechanism to repair, operate and maintain the technology, all by themselves and without any outside intervention and help.

05 If a rethink for distributive generation is adopted, one can witness many winners in MAs. The overall society would prosper because electric service could be provided on-ground, at lower cost and with higher reliability. National Electric Power Regulatory Authority (NEPRA), the electricity regulator, would achieve its objective of greater consumer well-being at fair and competitive prices. The federal government will benefit from a reduced fiscal risk exposure along with political mileage among their constituencies. TESCO will benefit through a higher return on assets since it will service well-paying industrial and commercial consumers. The industrial consumers will flourish, since they can have uninterrupted supply from the TESCO grid. Indigenous people will thrive since there will be a market for solar repair, maintenance, and ancillary services, attracting capital and creating jobs. And then there will be tangible social impacts as well. Schools, hospitals, often so neglected, will function whereas environment will benefit from lower air pollution, less deforestation and health hazards of using kerosene and biomass. The benefits will be widespread and will accrue across the value chain.

06 The MAs electricity sector can witness a profound and comprehensive change, including a return to the local and neighbourhood scale through adaption of widespread solar PV. This study, though only a diagnostic, can further lead to a first full and systematic public synthesis of how making electrical resources the right size can minimize costs and risks. There will be several tangible benefits, such as:

- The most valuable distributed benefit would typically flow to the Federal Government, from financial economics—the lower risk of fiscal impact through less subsidies in the long-run. Further, the Government can direct subsidies to installation of smaller modules with shorter lead times, portability, and low or no fuel-price volatility, hedging the community of inflation risks.
- There will be substantial electrical-engineering benefits—lower grid costs and losses, better fault management, reactive support, etc.—usually provide another advantage with more reliable power available to industrial consumers.
- Many miscellaneous benefits may together increase – such as development of newer economy models, where energy and employment come hand in hand for creating additional positive externalities to societies overall. Externalities, though hard to quantify, may be politically decisive, and yield long-term benefits.

07 Although, initial fears of energy transition for a more efficient frontiers are understandable, a transition will yield benefits to all stakeholders involved. This will require a two-pronged strategy, i) re-thinking TESCO's electrification objectives, strategy and profile and ii) deployment of a coherent distributive solar strategy to optimize benefits. For TESCO, there is a need to strengthen the existing infrastructure through upstream transmission connections with NTDC instead of existing connection with PESCO, and downstream distribution network up-gradation to reduce losses. Given the topography, TESCO is most suited for industrial segment with near hundred percent recoveries and a chance to grow employment opportunities for the local population. On the other hand, bulk of commercial and domestic segment should have an energy transition of load matching the needs where TESCO is unable to provide reliable and fiscally prudent electricity supply. There is also an urgent need to improve TESCO's operations through strengthening its corporate governance practices such as the incorporation of an independent Board of Directors (BOD), development of a pension fund, modernization of bookkeeping standards and resolution of taxation issues with the FBR. TESCO's performance and its corresponding services provided to consumers until now has demonstrated that subsidizing domestic consumers reaps minimal utility for both the government and the people. It is high time that Government puts the money (such as the funds allocated under Tribal Decade Strategy) to good use by directing it to more fruitful pathways.

08 Second, there is a need to layout a conducive groundwork required for solar energy augmentation and transition. These include introducing off-grid financing arrangements such as i) introduction of a Public-Private Partnership (PPP) approach with a viable transaction structure to distribute SHS products backed by monitoring through independent engineers and independent auditors, ii) developing feasibilities for mini and microgrids at the community level, and iii) awareness campaigns for proper maintenance and operation of solar systems to get the maximum benefit out of the systems already installed. Lastly, as part of rethinking the electrification strategy, the Government can take a whole new approach through adoption of a new energy-economy model. Advancements in new technologies, such as solar geysers and solar cookers, and encouraging its deployment can have the lowest pay-back period, highest returns on investment and maximum health and environment benefits. Conclusively, if a rethink for distributive generation is adopted, one can witness many winners. The overall society would prosper because electric services could be provided on-ground, at a cost lower than the grid power, at a scale matching its need, with improved health and environment benefits and with less reliance on fiscal budgets and subsidy allocations.

Background

09 Profile: The Merged Areas (MAs), formerly known as Federally Administered Tribal Areas (FATA), located in the northwest region of Pakistan, with an area the size of Belgium and population equivalent to New Zealand. The area has been deprived from basic constitutional rights since the independence in 1947. The absence of these rights paved way for the archaic laws, such as the Federal Crimes Regulation 1901 (FCR 1901), to exist up until the merger in 2018. The absence of most fundamental human rights resulted in a large communication gap between the Government and the people of MAs. As a result, the region lagged national average in all the Human Development Index (HDI). The Government consequently took a historic step in May 2018 by passing the 25th amendment to the constitution of Pakistan in the National Assembly, merging ex-FATA areas with Khyber Pakhtunkhwa (KP). It also provided an opportunity to stabilize the region that has long been dominated by war and terrorism and introduced constitutional rights to 5.5 million people by empowering the elected legislatures and extending formal rule of law including such as land title rights, election of local governments, and provision of basic human rights.

10 To accelerate the merger process and augment local development efforts, the Federal Government sanctioned an investment stimulus through the adaption of the Tribal Decade Strategy 2020-2030. Based on this plan, the government has allocated Rs. 100 billion every year for the next 10 years . Before the start of this program, an Accelerated Implementation Program (AIP) was initiated to set the ground for development works through Tribal Decade Strategy, including 206 interventions proposed in all sectors. For electricity sector, during the first year of AIP, upgradation of four 66 kV to 132 kV grids were planned while three 11 kV feeders were proposed for all districts to increase the distribution capacity of TESCO . On the generations side, 73.56 MW Chappari Charkhel Hydro Power Project was placed before Pakhtunkhwa Energy Development Organization (PEDO) Board of Directors for approval. This is one of the vital projects to connect with the national grid through National Transmission and Dispatch Company (NTDC).

11 Overall, the electricity sector of Merged Areas (MAs) is not entirely isolated with Pakistan's electric sector, which is at a crucial stage and remains under extreme financial pressure. The persistent load shedding cycle (up to 5,000 MW in 2013-14) triggered by technological, economic, commercial, and regulatory barriers has now shifted into an over-capacity market with high and unsustainable capacity payments. This has consequently led to low demand, higher tariffs, low network productivity, and ever-increasing circular debt (Rs. 2.5 trillion as of Feb 2021). The MAs have an abundance of renewable power resources with an aggregated capacity to power up the entire area. However, the Government has put the entire onus of providing electricity on TESCO, the local electric distribution company. In what is now an unsatisfactory outcome, TESCO has been able to provide electricity up to only 2-3 hours a day to domestic consumers. Schools, hospitals and employment generation prospects have all suffered and there remains a severe discontent among MAs population on the electricity supply outcome.

12 Nonetheless, the Government's central strategy to provide electricity to MAs revolve around TESCO alone. An estimated Rs. 10 billion has been allocated to TESCO for grid augmentation program, with equivalent spending to be made in the next two years to other unconnected, remote locations. Generally, with losses exceeding NEPRA allowed losses and recoveries of only up to 65-70 percent, any additional grid augmentation through TESCO will result in higher losses, higher circular debt, lower demand and consequent less reliability and operational capabilities. Today, TESCO represents a spiral of impossibilities scenario, with run down operational capabilities and complete reliance on the Federal Government for any budgetary support and fiscal challenges.

13 In this backdrop, one of the critical objectives of this diagnostic is to study, analyse and put forward facts on ground, that can pave way for an objective electricity policy assessment beneficial to all. This diagnostic is only a small step which can help propel further analysis, more detailed designs, technical feasibilities and long-term planning documents. We hope that policy makers as well as development partners can consequently lead the way in delivering assistance in the technical areas of project management, transaction structuring and efficient electricity design to provide affordable and reliable supply of electricity. Other important areas include altering the policy to cater to the demand commensurate to the needs of the people, implementing feasibilities and analytical studies, enhancing the private sector investment environment, and attracting foreign and local investors in small, renewable energy projects. Such activities can be carried out to identify and mitigate gaps, resolve institutional weaknesses, infrastructure planning, and investment shortcomings to harness energy for sustainable, long-term development.

14 To complete the study, we have undertaken extensive stakeholder discussions to conceptualize sector diagnostic. This would include meeting with several members of the provincial and federal government, most notably the Honourable Energy Secretary, KP and Chairman NEPRA. Additional meetings included meetings with the Chairman NEPRA, CEO / Managing Director and executive members of the Alternate Energy Development Board (AEDB), the World Bank Group, Member KP-NEPRA, Member of the National Assembly and several sector consultants and stakeholders. Stakeholder consultations were also held with private sector operators, especially solar PV developers. References from extensive literature of the energy and power sector were used that included NEPRA's state of the industry report, Sustainable Development Strategy KPK 2019-23, Sector Strategy, Demand Driven Competency-Based Training in KP, GIZ, IRENA: Pakistan Renewable Readiness Assessment Report, World Bank locational study report, Power System Statistics 43rd Edition-2018 and 2019,

and the Energy Yearbook. The literature used provided comprehensive and extensive information that enabled to develop a sector diagnostic that was a brief in elaboration to identify bottlenecks and recommend areas for improvement in different sectors.

15 The ensuing diagnostic would cover issues identified, based on the consultations and reference to the literature provided and incorporation of views on the topics discussed with key stakeholders, followed by recommendations for overarching goals for MAs electricity sector. The recommendations are a list of key entry points that are specific and identifies areas where further support can be provided by the development partners and the government. We hope that after extensive stakeholder consultations, investing in the designed entry points will reduce electricity inequity, improve energy access and provide further employment and economic opportunities in the years to come.

16 Approach and methodology: To fully understand the context of rural electrification of MAs, we have made an attempt to:

- Understand the dynamics of MAs including, but not limited to, tribal settings and laws, demographics, geography, and profiles of all 7 tribal districts and 6 sub-divisions.
- Study all projects and studies conducted in MAs, with particular focus on electrification challenges.
- Study the learning outcomes of already implemented rural electrification projects through review of case studies on rural electrification challenges.
- Develop multi-tier approach to identify issues and gaps in technical, financial as well as regulatory & policy areas.
- Understand the political economy challenges associated with electrification by conducting field surveys, stakeholder consultations and in-field interviews with both TESCO and community stakeholders.
- Proposing recommendations and key intervention points for future developmental projects in electrification strategy of MAs.
- Conducting advocacy sessions to disseminate our findings and absorb objective feedback.

17 We have tried that the research approach adapted for this study remains data-driven and evidence based. The diagnostic will support GoP and GoKP to develop recommendations and bring together a broad range of stakeholders in inclusive policy dialogues. Coalescing support around a range of interventions, this diagnostic study can help provide framework for future investments, regulatory designs and capacity building support. The overall methodology is categorized under three phases; Phase I: Data Collection and Survey, Phase II: Research and Analysis, Phase III: Results and Recommendations. All phases are critical for a prudent diagnostic and can be viewed with an appreciation of how they interact, as the result of one step could constitute or affect the input of the other.

18 Multi-disciplinary Approach: We delved extensively on on-ground assessments and literature review. To back our assessment, we also organized stakeholder consultations with and through government, private and development partners to suggest interlocking interventions that can support the changes required in governance and institutional structures. The approach unified activities under three mutually reinforcing components, namely:

- Data collection phase (literature review, field visit, interviews, surveys, stakeholder consultations)
- Research and analysis phase
- Results and recommendations phase.

19 Fundamental and Application-oriented Research: Our focus was to undertake a three-way approach, i.e., to evaluate issues under technical, financial, and policy/regulatory areas. We believed that all three areas should not be looked in isolation but together as one. It is using a synthesis evaluation of multiple approach that we have been able to conduct an honest evaluation of the challenges faced, such as how much electricity can be provided at a cost that is affordable to all and under improved change management and regulatory practices? Limiting the diagnostic to any one aspect could have limited the scope of the study and may not have provided findings that are technically correct and prudent in political economy ways.

20 Key Interlocking Interventions: The diagnostic framework attempts to answer a broad-based electricity framework and should not be construed as a comprehensive guide on recommendations or technical planning. We have touched down multiple topics (such as multilayer and full-range power sector planning at TESCO level, procurement, facilitation of governance and policy reform including private sector participation, facilitation in off-take of distributive generation, improvement of commercialization, grid mapping, grid code improvement, smart engineering design, public-private partnerships, access to finance, transaction due diligence and facilitation, legal and regulatory requirements for mini-micro grids and capacity building and change management) with an aim that a broad based diagnostic, covering all issues concerned can help stakeholders absorb full magnitude of problems. The recommendations should be construed only as entry points with an aim to build on important activities for long-term development prospect.

Introduction

"This is the best of times; this is the worst of times" – Charles Dickens

21 Amory Lovins wrote a ground-breaking paper on hard versus soft energy paths, which hugely impacted the way the United Stated envisioned its future energy policy . A hard energy path, as Lovins argued, intensified business as usual with little benefits. A soft energy path, on the other hand, is modular and is built keeping customer requirements in mind. In the case of MAs, TESCO represents a hard energy path — focused on laying lines after lines, incurring capital expenditures, building grid stations, setting up buildings, installing transformers, and incurring expenditures which are costly, dirty, slow and inefficient. As Lovins explained, a hard energy path becomes feasible for none, always fiscally overwhelming, and constrains governmental budgets for much needed other investments. A soft energy path matches customer requirements in scale and evolves as per the needs and the requirements of communities. Looking from this lens, MAs represent two possible future energy paths – one which is rigid and un-modular and second which is flexible and adaptable.

22 The worst of times: Under the challenges reflected in the study, TESCO represents a worst of times. A hard energy path, which after continuous investment (Rs. 77 billion from 2014-2020 alone in Tribal Decade Strategy, Rs. 50 billion under PSDP) has only been able to provide power to 57 percent of the villages, at maximum of 2-4 hours of the day. Schools have remained un-operational, hospitals have relied on generators, businesses given intermittent power supplies and labour unable to find employment opportunities at home. The result is a general energy poverty, marred by socio-economic disparities, lacking energy access that can only aggravate from hereon. Any dangerous delays in the transition will exact more money, more time, more commitment to reform, and an even higher political price to fund hard technologies. At a larger scale, TESCO also represents a domination of an energy infrastructure that demands central control and increase bureaucratization. TESCO's hard energy path has become impenetrable and un-democratic with no bottom-up feedback from end consumers. People who consume energy do not participate in planning and have now become alienated from the government and its service delivery mechanisms.

23 The best of times: On the contrary, what has surfaced is completely grass-root, democratic, matching in scale and a distributive energy resource. MAs represent a community which is connected hundred percent on solar energy (the only exception is industrial consumers). Whether they are commercial markets, domestic consumers, hospitals or schools, nearly everyone is connected with solar energy. Families, markets, hospitals and schools have adapted the technology at the heart of their every daily lives. Most of them are small-scale (6KW-10KW), distributed, designed for local social and ecological conditions, and owned and controlled for community wellbeing and resilience. The solar PV adaption has provided employment opportunities at the doorstep and so far, has come with a net-zero fiscal burden to the federal or provincial governments. It has ramped up willingness to pay for associated energy products (such as solar lights, DC fans etc.), has driven consumer demand and preserved well-being for local environment. Any concerted focus from the government can warrant renewable energy transition to promote and facilitate public support for energy justice, community resilience and participatory democratic politics in the long run. Only the MAs represent Thomas Edison's vision of a decentralized power system in Pakistan in its true letter and spirit.

24 The path we envision: The electricity reality in the MAs need to be told across Pakistan. It is a story of how a small, war-torn area, with a false illusion of grid electricity has embraced a distributive source to power employment, education and development opportunities. The sector is in the midst of profound and comprehensive change, largely betting on solar PV as the go-to option for all consumption – except industrial.

25 Currently, TESCO which is serving MAs from large grid extension projects and through centralized dispatch is yielding little to no result, creating only scarcity and sub-par customer services. TESCO's elaborated technical and engineering systems command the flow of electrons from central dispatch to dispersed, remote users with consequent no flow of money back to pay for capacity payments, power stations, fuel, and grid. This architecture can make sense for only a limited number of years, such as in the current post-merger scenario, but certainly not forever. The power stations will become more expensive and with low recoveries, TESCO's grid will only become less reliable to ensure economic dispatch. The grid melds diverse loads of many customers, sharing domestic feeders with commercial, commercial feeders with industrial etc., and creating an engineering mess that only requires larger resources to fund existing traps.

26 From here on, it is important to envision a better future. As per our findings, the cheapest, most reliable power would be near the customers and closer to the source. TESCO's traditional focus overlooks larger diseconomies of scale, ballooning operational costs, increasing organizational bureaucracy, and a slow responder to consumer needs. If continued, a narrow vision to power with centralized network will only end up raising costs and financial risks for the Government. What we have found is the enormous differences of scale between what most people generally consume on the ground (such as lighting, heating, washing clothes etc.,) and what they are being provided with (through large, capex driven grid extension projects). It seems that almost 75 percent of MAs domestic and commercial customers use electricity that do not exceed few KWhs daily. There is an urgent need to better match resources to the kilowatt scale of most customers, or depending on technical feasibility, to a microgrid scale, providing important economic advantages over the giant systems.

27 There are challenges in off-grid areas use of solar energy too. A palpable issue that we have witnessed is the use of below-par solar panels, often cheaper replicas that don't last long (the average panel cost is 15-20 cents/watt as compared to 60-90 cents/watt of a better-quality panel). These solar panels are largely imported from China and often lose out on quality aspects. But even they provide increased value—due to no fiscal risk to the government, engineering flexibility, energy access especially to the under-privileged, improved environmental quality, and other important attributes which offsets their apparent cost and quality disadvantages. Perhaps their biggest advantage is a shift towards privately competing players, not requiring any elaborate regulatory design, a subsidy push or market restructuring practices. A simple, on-ground, private sector led solar PV growth is contributing to local economic development agenda.

28 Since this is a preliminary diagnostic, and not an entire subset of electrification issues, our study reflects on-ground practices instead of a detailed technical analysis. We only seek to provide a synthesis of how distributive resources can minimize future risks and costs. The path we envision is as follows:

1. If pursued prudently and with a sound policy design, the most valuable benefit of distributed electrification can result in favourable fiscal benefits, such as deployment of lower risk of smaller modules with shorter lead times, smart handling capability, on-ground engineering solution and no inherent fuel-price volatility, providing people a hedge against inflation risk. None of these benefits are present for TESCO.

2. Distributive generation can match end user needs and will optimize engineering benefits. These include lower T&D losses, improved fault management at the local level and proactive repair and maintenance support. All this gives a substantial value gain. In the MAs, each household has a solar PV, which ensures that one systems power quality or reliability issues does not cascade to others.

3. A private sector led electricity market structure can provide widespread incentives, as well as the measurement and validation to give distributed benefits a market voice. Private sector players willing to solve local electrification problems will result in competition and will consequently improve investment decisions by driving down prices. The Government on its part can aid a distributed model, through market framework and policy framework. This transition can promise a competitive, resilient, and financially viable electricity sector, at a cost much lesser to customers and to the earth.

4. The Government undertakes an effort to understand the needs and wants of the consumers on ground, providing them a solution matching their needs instead of only giving yearly subsidies. As have been suggested, TESCO can only facilitate industrial consumers, increasing their consumption to 1,000 MW by 2023 and incentivizing electricity off-take for larger employment benefits. On the other hand, Government can focus on domestic and commercial consumers by subsidizing transparent off-take of solar panels. There are other various policies that the government can offer. These can include tax-free import of high-quality panels for rural electrification, tax incentives for developers, grant programs, loan programs, personal and corporate tax incentives (credits, deductions, and exemptions), rebate programs, and income tax and sales tax incentives. An effective policy design will eventually result in lower annual subsidies, improved rural development, less fiscal constraint and a community fully capable to walk the 21st century standards – and leapfrogging the rest of Pakistan.

Limitations

While compiling this report, we feel to highlight the below limitations of our study.

- To have a more robust and accurate picture of baseline situation, it requires an extensive technical feasibility or a detailed survey with a comprehensive sample set. However, the limited time and scope of this study kept the survey exercise to data set of 200 people in all 7 districts and 6 sub-divisions. Nevertheless, this survey results could help build up on future detailed surveys and provide insights on developing the right questionnaire.
- Ideally, such study requires a comprehensive field visit in all districts/sub-divisions to understand the ground realities and get a feel for dynamics of all areas. However, due to timeline constraints and security situation, the field visits were limited to Khyber and Mohamad Agency.
- The diagnostic team carried out a preliminary data analysis based on the data available from the general stakeholder consultations, and through secondary research. However, a comprehensive evidence-based analysis based on the real time surveys and primary research was restricted by the timelines of the project.
- While there is significant data available on Pakistan's energy sector from a macro perspective (electricity, tariffs, generation, regulation), there is limitation of data available on the MAs' energy sector, including some of the sub-sectors such as energy efficiency, distributive generation, and rural electrification. Lack of available data limited the scope of our analysis in finding a trend and a meaningful relationship between different variables, especially for some sub-sector data analysis. However, we also see an opportunity for future sector leaders, development partners to collect, archive and make public data on energy sub-sectors in the MAs for future research purposes.
- COVID-19 restricted the research team from carrying out in person stakeholder consultations with all the stakeholders.
- Last, security situation in MAs especially to areas such as South Waziristan and North Waziristan restricted our travels to MAs. While we were able to see firsthand information in Mohmand and Khyber, we would have liked to spend more time in the field had the security situation was more favorable.

Merged Areas' Electricity Profile

Grid Electricity Profile

30 In 1992, the unbundling of WAPDA under power sector reforms, led to the formation of distribution companies (DISCOs), wholly owned by the Government of Pakistan. The distribution companies had the business of distribution, as well as the sale of electricity to end consumers. The Government has recently amended this function under two separate functions of supply and distribution vide NEPRA Act Amendment 2018. The distribution company serving tribal areas, known as the Tribal Areas Electric Supply Company (TESCO), was incorporated in 2002 under PEPCO administration, and the Ministry of Energy & Power Division. However, it was granted distribution license on 12th August 2013, with an exclusive territorial network to supply and to distribute electricity in the MAs. TESCO was split from the original company Peshawar Electric Supply company (PESCO) with an aim to determine its own billing and subsidy requirements. In essence, TESCO operates as autonomous license distribution company and manages its operations independently in the area.

31 The MAs continue to endure a severe electricity crisis over the past decade, with long blackouts, marred by adverse security conditions and law and order issues. Almost all sectors, including commercial and industrial operate at below optimal levels because of inadequate power supply. As a pre-condition to the merger, the people of MAs were promised a no change in status quo, which included provisions of free electricity supply, free natural gas supply and zero-taxation. In particular, the electricity supply to domestic consumers have been exempt from payment of bills through a Statutory Regulatory Order (SRO) and is valid till June 2023. Nonetheless, free supply of electricity has resulted in a disproportionately high demand, coupled with sub-par customer service, low infrastructure investments, high average cost of power supply and resulting low consumer welfare, particularly the poor.

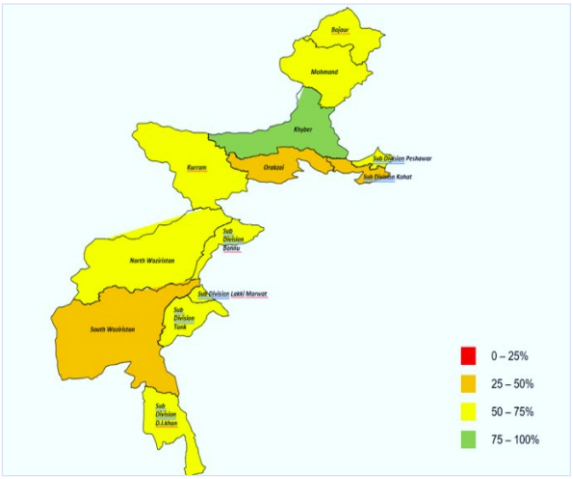

Figure 1: Merged Areas electrification map

32 Over the years, the Federal Government has supported the MAs electricity sector through dedicated subsidy for domestic consumers while also improving power system's reliability and efficiency through grid and infrastructure upgrades. On ground, however, only limited progress has been made. High fiscal deficits and underlying circular debt (i.e., cash shortfalls across the power supply chain), has rendered TESCO and federal government unable to finance grid expansion projects fully. In addition, there is a pressure to cut down existing subsidy levels.Figure 2: Village electrification trend

33 Overall, TESCO grid provides up to 57.3 percent of electrification coverage with maximum power demand of 800 MW against the average power supply between 250 – 280 MW. The limited distribution and transmission network, coupled by an un-controlled demand, along with low investments in network upgradation have become major obstacles for TESCO. In recent decade, the average electricity consumption per connection in TESCO has witnessed a decrease in commercial and agriculture sectors, while domestic and industrial consumption per connection which has increased. For past 5 years, the average electricity consumption has been relatively constant between 250 kWh to 300 kWh per capita, which is lower as compared to many African countries (See Figure 3) of the same topography and demographics and lower still of average consumption of 470 kWh per capita in Pakistan. Given the large number of un-metered connections, it is difficult to estimate the actual number of households with grid electricity supply. On per connections basis, the average consumption per meter for commercial connections have decreased from 22 kWh in FY 2015-6 to 14 kWh in FY 2019-20, implying that more commercial meters may have been given to consumers but per supply of electricity has not improved.

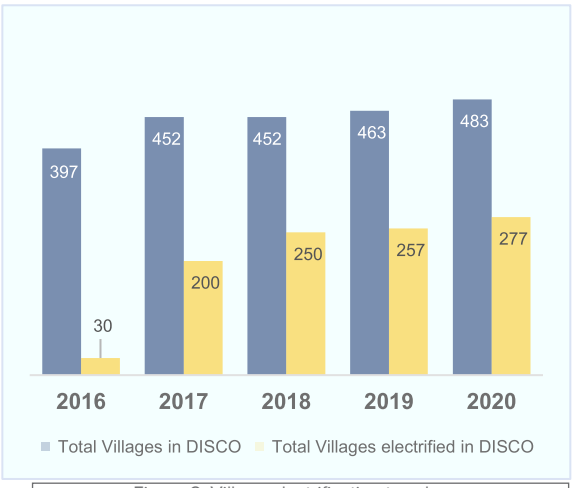

Figure 2: Village electrification trend

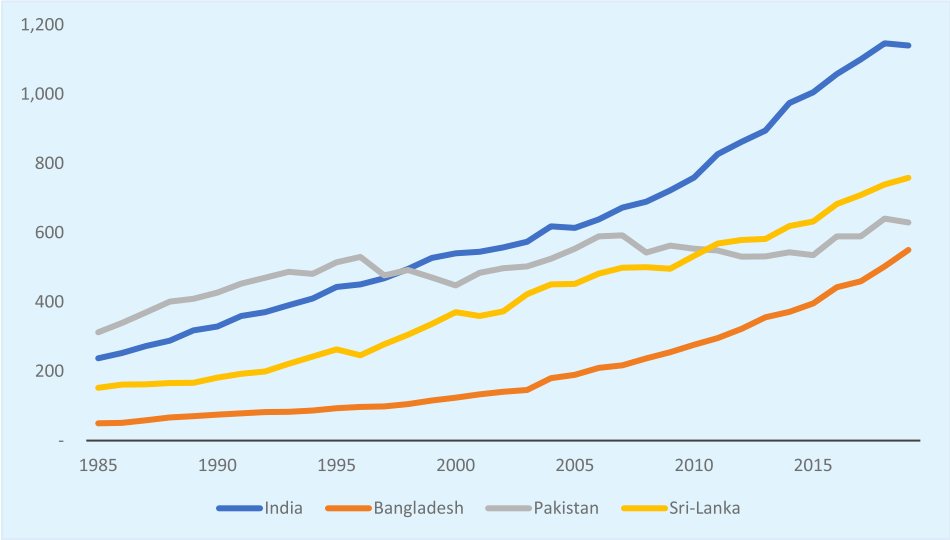

Figure 3: Annual electricity consumption per capita in countries (kWh)

Government Support to TESCO

The Federal Government has supported the electrification of MAs at two core levels: (i) to provide for institutional and policy support, and (ii) to stipulate subsidies and investments in grid infrastructure. The policy support has come at different levels, initially from enactment of institutional unbundling of TESCO from PESCO as well as instituting merger pre-requisites, such as the promulgation of an SRO, which exempts domestic consumers to pay electricity bill till 2023. On the investments side, the federal government has provided for investments through Public Sector Development Program (PSDP) to eliminate grid and infrastructure bottlenecks and to undertake village electrification projects for universal access to electricity across MAs. The total subsides given to the MAs from FY 2014-15 to date amount to almost Rs. 80.7 billion. During this timeline, the actual subsidy given during FY 2014-15, FY 2015-16 and FY 2016-17 were always more than the budgeted amount at the start of the respective years. Post-merger, the government has devised a 10-year development plan to bring MAs at par with rest of the province. As energy remains the backbone of rural development, an Accelerated Implementation Plan (AIP) was initiated with specific focus on enhancing grid connectivity in the region. In FY19, TESCO expanded their operations area by installing additional 1,745 km high transmission lines under AIP and Annual Development Plan (ADP) schemes. TESCO grid expansion plans under AIP scheme include expansion of grid network and rehabilitation of existing network. For this purpose, an extensive list of projects has been taken up on the distribution side, which includes: 34

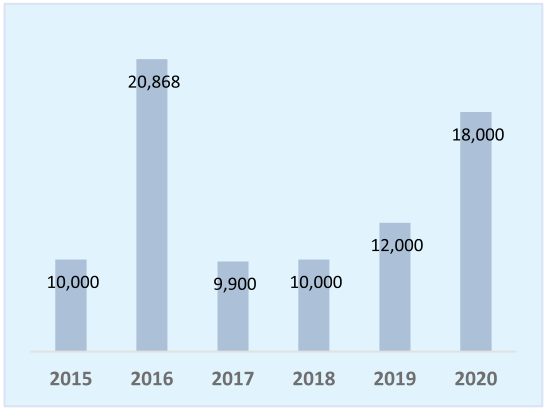

Figure 4: Tariff differential subsidies to TESCO (Rs. Million)

- Reconducting of existing feeders,
- Bifurcation and trifurcation of feeders to mitigate overloading and Establishment of new grid stations and upgradation of 66 to 132 kV Grid stations.

In total, an investment plan for FY 2019-20 amounting to Rs. 2.5 billion has been mobilized for grid upgradation projects. However, the overall financing falls short of what is required to electrify the area completely with a reliable electricity network. The investments will enhance the load capability to increase from 247 MW to 507 MW by FY 2023, whereby the overall electrification coverage will increase from 58 percent to 76 percent. Under a three-year horizon, an additional development plan of Rs. 11.7 billion has been laid out that will be mobilized under three categories as follows: 35

Table 1: TESCO three-year investment plan

Proposed Investment (Rs. Billion)	
132kV Grid Stations and Transmission Lines to from NTDC	7.2
132 kV Grid Stations Upgradation	2.2
Future village electrification activities	2.3
Total	**11.7**

36 **The Demand Supply Gap:** There is an extensive electricity demand-supply gap, roughly estimated at 600 MW, with peak demand at 850 MW. This has led to frequent load shedding, which as per our stakeholders' consultations is around 18-22 hours a day. The situation is always worse off due to technical and grid challenges, which constraints the maximum supply of 250 MW at the consumer level. To reduce the demand-supply gap, the federal government has devised a three-step approach. The first step is to augment the transmission grid capacity, enhancing the evacuation and ring fencing it directly with 220 kV NTDC network as opposed to its current network connected with 132 kV PESCO circuit. The second step is to augment the distribution capacity through LT network via extension of 11 kV lines, building and installing transformers and ensuring the supply is metered. The third step is the village electrification that remain unconnected to the grid.

Table 2: Demand vs actual supply of electricity in TESCO

TESCO Demand-Supply Gap (Gwh)	2017-18	2018-19	2019-20
Expected Demand	2,519	2,818	3,153
Actual Sale of Electricity	1,482	1,603	1,803

37 The demand-supply gap has dampened developmental prospects, particular the disadvantaged. With limited electricity supply comes limited opportunities for education and healthcare. The situation has also poorly affected economic sectors, such as industrial and commercial off-takes. Though there is evidence that off-grid methods, especially solar power has become popular in MAs, some industrial and commercial facilities have invested in back-up generators to keep functioning during load shedding hours.

Table 3: TESCO category wise electricity sold

Sub-Sector (Gwh)	2015-16	2016-17	2017-18	2018-19	2019-20
Domestic	881	1,018	1,195	1,213	1,415
Commercial	7.49	6.86	5.93	5.13	4.90
Industrial	88	145	228	327	330
Agricultural	44	50	42	36	33
Bulk Supply	8	8	9	9	10
Others	-	-	2	12	10
Total	**1,028**	**1,227**	**1,482**	**1,603**	**1,803**

38 In the past five years, overall electricity sales grew by 12.8 percent per year in TESCO. Overall, the ratio of grid electricity consumption of the industrial sector as compared to the overall consumption increased from 9 percent to 18 percent from FY 2015-16 to FY 2019-20. Nonetheless, the grid supply to industrial consumers remains at below optimum levels. The most affected are energy-intensive manufacturers such as marble producers, which as per our field visits have suffered a loss of productivity of 50 percent or more for unreliable power outages as compared to the overall marble industry nationwide.

39 Financial Profile: As highlighted, the financial situation of the electricity sector in MAs remains precarious. The chronic shortfall between cash inflows and outflows at TESCO render it completely reliant on the Federal Government support, mainly through subsidies. An ever-ballooning circular debt, puts additional pressure for further network expansion. Shortages of inflows stem generally from three main factors: (i) there is no concept of cost recovery tariffs as domestic consumers comprising of 93 percent of total consumer base are exempt from paying electricity bills, (ii) the Federal Government fails or delays payment of Tariff Differential Subsidies (TDS) to TESCO, which in turn do not pay to CPPA-G or the provincial government delays payment of Accelerated Implementation Program (AIP) receipts for network expansion as envisaged under Tribal Decade Strategy; and (iii) tariff determination and/or notification is delayed, so TESCO is caught between the actual costs for a period, the determined tariff for another, and the notified tariff for yet another one. In the entire scenario, weak fiscal situation results in sub-par operational capabilities, creating a spiral of impossibility scenarios and culminating into a vicious cycle.

40 Specifically, TESCO's receivables have reached Rs. 56.1 billion as of December 2019 (about $ 349.5 million), as more concerted reforms were delayed, and subsidy and tariff issues were not addressed. There are also recovery issues in hard to visit areas for commercial and industrial consumers, and there are also anomalies with taxation structures of the Federal Bureau of Revenue (FBR). In summary, the main factors behind a weak financial profile are as follows:

- TESCO has continued to report technical and commercial losses that exceed NEPRA's targets (More than 16 percent actual losses against 11.9 percent NEPRA allowed).

- TESCO has difficulties collecting payments from electricity bills invoiced to private consumers. Such shortfalls can represent up to 29 percent of the bills, which essentially means that billed consumers pay only about 70 percent of what they are invoiced. Non-collected dues from private consumers have also been on the rise.
- The domestic consumers of MAs, though accepts NEPRA-determined tariffs, does not pay cost recovery electricity tariff since the SRO has exempted domestic consumers to pay electricity bills up to June 2023.
- Delays in subsidy and AIP payments create a mismatch regarding what TESCO can invest as per regulated Integrated Generation Transmission and Distribution Plan (IGTDP) and what they eventually invest.

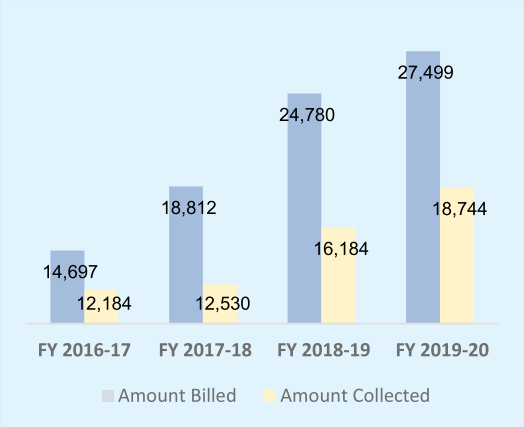

Figure 5: Recovery trend in TESCO (Rs. Million)

- There are issues related to the Federal Board of Revenue (FBR). There have been disputes between TESCO and the FBR as to whether the sales tax should be charged on invoiced or collected amounts. The difference arises from technical and commercial losses over NEPRA's targets, bills to the government of some regions that do not pay their bills in full), and arrears on the Tariff Differential Subsidy (TDS) paid by the government. Further, FBR delays the refund of the withheld sales tax, increasing the receivables at TESCO's end. FBR in the past, has also attached TESCO's accounts on non-payments of taxes.
- There are lingering issues with PESCO receivables. Currently, the amounts of receivables for PESCO amounted to Rs. 157 billion, out of which TESCO owes PESCO Rs. 37.3 billion as of December 2019 for Use of System Charges (UoSC) . Similarly, the receivables of TESCO, amounting to Rs. 56 .1 billion, were bifurcated into Rs. 2.1 billion for the public sector and Rs. 53.9 billion as receivables for the private sector.
- As circular debt is directly proportional to the amount of sales, the more expensive the cost of supply owing to higher inefficiencies, the higher the difference between collections and the billed amounts. If TESCO is able to supply more electricity in the future, higher electricity supplies can only exacerbate the current circular debt problem, as costs will increase faster than net recoveries.
- Although, the amounts of billings and collections have increased in the past four years, the percentage of collections has remained almost stagnant. A closer analysis of the collection suggest that the Bulk Supply have the highest collection rate, with 73.26 percent. Domestic sector follows second with a recovery rate of 72.05 percent, primarily because federal government subsidy is treated as revenue for the exempt supplies.

Operational Profile: One of the major challenges is the continuation of un-metered electricity supply to TESCO. For end consumers, metering is often perceived as a precursor to billing, which prompts them to avoid all sorts of metering establishment and continue to operate in an un-metered status quo environment. The lack of metering implies there is little energy accounting framework to calculate energy inflows and outflows at 132 kV, 66 kV, 11 kV and eventually at the consumer level. The result is an undocumented energy economy, with no substantiated data to plan a way forward. To mitigate this, several attempts have been made in the past to meter MAs electricity flows. However, all attempts have met resistance with very little headway. The consequence of an un-metered supply backed by free electricity has resulted in an uncontrolled demand. The supply is often wire-tapped (so-called 'kunda') through meter by-passing across the MAs. All readings are roughly estimated based on reading differences at the substation level estimated by the field staff. Considering the widespread extension of the wire-tapping practice, there is a need to initiate a metering drive in cooperation with local governments, provincial government, TESCO, and law enforcement agencies. A concerted effort is required to survey, investigate, report, and promulgate a metering regime. Such an activity can be undertaken phased wise, starting first with industrial, commercial, and high-end domestic consumers (load more than 5KW), followed by domestic consumers of load less than 5 KW. 41

The transmission and distribution systems are archaic in nature, are heavily loaded at critical Common Delivery Points (CPDs) and 11 kV systems and merit investments to prevent further supply bottlenecks. Network bottlenecks, with many sections substantially loaded above their stipulated ratings, and low voltage capacity have prevented the addition of new loads. Distribution systems have become the holdup and frailest link of the TESCO power network, and faces constant overloading and voltage drops. In FY 2020, it was reported that 79 percent of 11 kV feeders and 35 percent of distribution transformers were overloaded . Further, investments have not been anchored on long-term plans for generation, transmission, and distribution systems, keeping in mind the needs and wants of eventual consumers. The end consumers need heating and lighting instead of 11 kV lines submerged under operational inefficiencies. As the ground evidence suggests, efforts from the government needs to shift to the needs of the end user instead of grid extension projects, which have only proved financially fragile and fiscally imprudent from a long-term service delivery standpoint. 42

Governance and transparency also merit immediate attention. The Board of Directors at TESCO have virtually remained absent since its incorporation, resulting in a CEO all powerful, and directly reporting to the Ministry of Energy. There are no independent directors, resulting in a compromised accountability, procurement, and 43

performance regime. Generally, appointing members of BOD is carried out by the federal government. In the past, political considerations have guided such nominations, reducing the independence of directors, and limiting the transparency and public outreach. In addition, there is also an issue of vacant, unfilled HR positions. Out of 2,500 sanctioned positions at TESCO, roughly half is only filled. The consequence is weak field formations with limited ability to cater to technical on-ground challenges.

Figure 6: Operational snapshot of TESCO (Rs.)

Domestic/ Commercial/ Agriculture

		Industrial	
Arrear's amount (Domestic)	39.1 billion		
Arrear's amount (Commercial)	3.3 billion	Arrear's amount*	8.8 billion
Arrear's amount (Agriculture)	4.2 billion	# of industrial feeders	43
Per capita consumption^	300 kWh		

44 **Regulatory Profile:** The electric regulator, NEPRA has directed TESCO on number of important issues since its inception in 2013. For instance, NEPRA has remained consistent to raise the issue of un-metered domestic electricity supply. In FY16, NEPRA highlighted that it remains cognizant of TESCO's unmetered domestic consumption and directed it to expedite the metering process. It further directed TESCO to start taking metering snapshots for monthly billing purposes. Similar directions were reiterated in 2017 and 2018, however, the pace of work has remained slow. Second, NEPRA had directed TESCO to conduct an independent evaluation of its T&D loss targets including 11 kV & below LT network. NEPRA highlighted that such a study would help in identifying potential areas for improvement. In 2014, TESCO apprised that it has prepared the TORs of the study. It later apprised in 2016 that the work has commenced on the study by an independent third party, Power Planner International (PPI). The eventual results of the study showed that the transmission losses incurred at TESCO were around 4.08 percent, while no count of distribution losses were made. This was established as a benchmark for determining future transmission losses.

45 Third, NEPRA had asked TESCO to submit their plans regarding introduction and expansion of Automatic Meter Reading System (AMR) and Automatic Metering Infrastructure (AMI) at all Common Delivery Points (CDPs). NEPRA directed to i) install AMR and AMI at all their CDPs by 31 December 2015, ii) install AMR and AMI on the receiving end of at least 30 percent of their 11 kV feeders by 31 December 2015 and remaining 70 percent till 30 June 2016, iii) and to initiate AMR/AMI at the consumer level in at least 10 of their high loss-making subdivisions by 31 December 2015 and remaining 70 percent by 30 June 2016. In 2016, TESCO reported that it has commenced work on this project and that more than 50 percent AMRs have been installed at 11 kV feeders. Later, in 2017, TESCO reported that AMR systems have been implemented where communication network is available but did not provide any details with respect to exact numbers of installations at CDPs, 11 kV feeders or at the consumer level. NEPRA highlighted that TESCO needs to put in a serious effort to complete the installation of AMRs/ AMIs system at its earliest, which was again reiterated in 2018.

46 Last, NEPRA directed TESCO to use the Energy Monitoring Cell (EMC), established at the Finance Department, GoKP to monitor its recoveries, especially from domestic consumers, which remains poor. NEPRA also noted that recoveries from industrial consumers could also be increased if law enforcement agencies were involved. The EMC advised that TESCO should provide units to the category where higher recovery is expected and to provide less units to the domestic consumers where recovery is negligible.

Off Grid Profile

47 The usual pathway for electrification followed by developed countries has been to provide uninterrupted and reliable power supply through centralized grid for whole population. However, such may not be possible or economically viable for a region like MAs where 42 percent of population has no access to grid and even the portion connected to grid receives only 4-6 hours of electricity. In such scenario, it becomes imperative to start combing through alternative solutions in which the renewable energy models stand at the forefront. MAs have a lot of potential when it comes to solar but lacks in wind and geothermal resources availability. The hydel potential remains significant in certain northern parts of the region with potentially mega projects like Mohmand Dam.

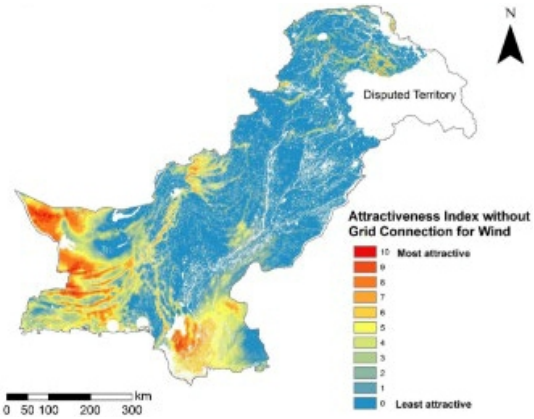

Figure 7: Financial attractiveness of wind power in Pakistan

48

Wind: Pakistan is rich in wind resource availability with one of the most suitable wind corridors present in Sindh. However, MAs do not fall in the ambit of those corridors and essentially have very low wind resource availability which makes it technically and financially unfeasible. Figure 5 show the wind resources availability in Pakistan, with Northwest region being the least attractive region. Under the attractiveness index of World Bank Locational Study of Pakistan for Variable Renewable Energy, northwest region including MAs remains least attractive overall. Although, a very small wind corridor could be identified in southern districts, the absence of grid connectivity in that area makes wind energy least viable option. Consequently, there is no wind turbine installed in the region of Mas.

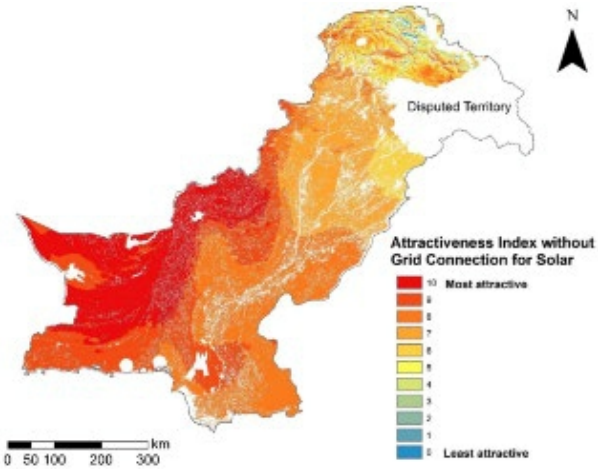

Figure 8: Financial attractiveness of Solar (w/o grid connection)

49

Hydel: Pakistan nationally generates 30.77 percent of electricity form hydel sources with most of the major dams situated in KP region . However, the MAs, with exception of few sites, lags KP in terms of hydel potential. The biggest hydel resource in MAs includes Mohmand Dam (under construction – 800 MW). Additionally, small dams including under construction Chapri Darkhel Dam (10.5 MW) in Khyber Agency, and operational 17.4 MW Gomal Dam in South Waziristan. Moreover, there have been raw sites identified in MAs for in Tank Zam at Frontier Regions.

50

Solar: Pakistan's overall solar potential is promising with most of the southern and western region showing promising solar attractive index. The WBG locational study results , as shown in Figure 6 and Figure 7, shows overall good resource potential availability for MAs; southern districts being the most attractive. The study further shows the attractiveness index with grid connection for solar PV, which shows a useful insight on mini-grids feasibility that could be connected to grid later. Regions like North Waziristan have 32 kV grid stations and subsequent feeder lines whereby the solar radiance also stays at peak. However, a comprehensive detailed feasibility needs to be conducted. Post-merger, the KP government is inclined towards promoting industrialization and agriculture sector through provision of electricity at doorsteps. As part of transition to renewable energy at the national level, GoKP have initiated certain off-grid projects. These include solarization of 300 mosques and other places of worships. The Government has also planned to construct 13 mini-solar grids in MAs to provide uninterrupted power supply to commercial and industrial consumers. (WBG,2021)

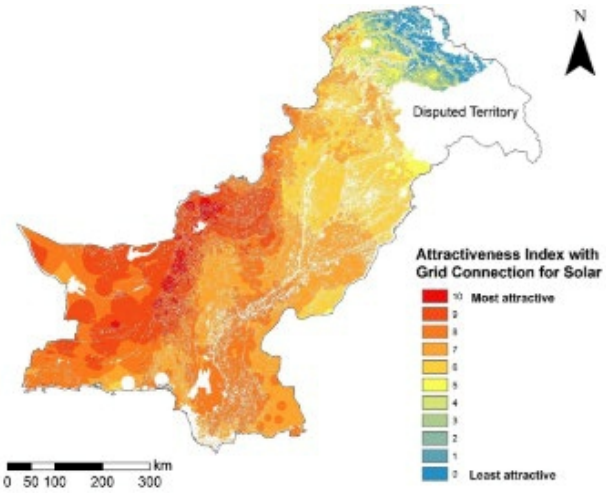

Figure 9: Financial attractiveness of Solar (with grid connection)

51

Currently, merged areas have adapted solar PV technology at the heart of their daily lives with almost every household having either SHS systems or Pico solar devices. The field visits to Khyber and Mohmand Agency showed solar plates on almost every rooftop. However, most of these plates are assembled, in rather an in efficient or informal system, without any safety mechanism like breakers or charge controllers for batteries. Moreover, the plates were seen laying on the rooftop without any inclination angle for optimum use of solar radiations. On maintenance side, people lack the capacity and awareness for maintenance of the system like cleaning the plates. A common misuse of the solar system was noticed in which almost all the plates on rooftop could be seen with dust coverings. The usual market players for solar developers are the locals in the area that provide solar panels and batteries on retail as compared to the whole system. The end users are generally responsible

Key Issues and Challenges

52 Providing electricity is highly capex driven, and an almost unimaginably a mega enterprise. In the MAs, the government has invested more than Rs. 166 billion since 2014 in Tariff Differential Subsidies (TDS) and almost the same in infrastructure development under Public Sector Development Program (PSDP). Per unit of delivered energy to MAs is more capital-intensive, largely due to rough terrain, unique topography, and remote locations. On per unit basis and accounting for direct and indirect losses, electricity produced from the grid is a far costlier form of energy than direct source, such as solar PV. The challenges outlined below are what we have witnessed on the ground, through field visits and on-site interviews. To better understand electrification challenges in MAs, we have bifurcated this section under two main challenge areas; one for on-grid electricity provided by TESCO and the other for off-grid solar PV, which is a more ubiquitous source of electricity in Mas.

TESCO – Grid Electrification Challenges

Unmetered Domestic and Commercial Segments

53 One of the major issues pertaining to TESCO is an un-metered supply of electricity to domestic and commercial consumers. Currently, more than 90 percent of domestic consumers are unmetered. Though government has taken several metering initiatives in the past, almost all of them have yielded little to no result with limited acceptability of metering regime. Metering is often considered a precursor to billing, which the locals have avoided to stay in a status quo environment – with the Federal Government promising an exemption for domestic consumers to pay bills till FY 2023. One such effort was initiated in 2015 when domestic meters were installed but were quickly damaged or stolen. So far, almost all metering exercises have met stiff resistance.

Commercial Meters in Mas

Commercial TESCO meters installed at shops in Jamrud bazaar of Khyber Agency were transferred to poles by the shopkeeper with many of shopkeepers removing the connections completely due to unreliable electricity supply. They mainly rely on solar for general use and generators for special purposes.

54 There are several issues associated with an un-metered electricity supply. First, there is lack of energy accounting framework at Common Delivery Points (CDPs). This implies that there is no record to attribute energy consumption and its costs, especially for units sold to domestic and commercial segments. In such a scenario, it becomes highly unlikely to compare how electricity usage is changing over time. Further, without consistently tracking electricity use, no one can identify problems (such as demand-supply gaps). Also, lack of energy accounting framework provides a shallow basis to prioritize capital investments. It becomes difficult, for instance, to prioritize investments on lines, transformers, and grid stations if there is superficial data available on ground as to which area requires urgent attention. Last, it becomes difficult to get anyone to take responsibility to carry out energy management activities since there is little incentive to do it. A Sub Divisional Officer (SDO) or an Executive Engineer (XEN), for example, may not see much benefit in reducing operational losses if the supplies continue to go unmetered. In the absence of metering, TESCO lacks the load information required to optimize grid performance. There is limited availability of data on system transmission and distribution losses since the exact quantum is never known. For instance, TESCO has continued to report technical and commercial losses that exceed NEPRA's targets (More than 16 percent actual losses against 11.9 percent NEPRA allowed). In 2016, Power Planner International (PPI) conducted a study showing that the transmission losses incurred at TESCO were around 4.08 percent, while no count of distribution losses were made. This was then established as a benchmark for determining future transmission losses and were considerably higher than the actual.

Uncontrolled Grid Demand

55 Perhaps one of the most significant repercussions of an un-metered electricity supply is uncontrolled demand. Based on the findings from TESCO, on average 6 hours of electricity is dispatched to the domestic consumers in all districts. However, on-ground interviews suggest that even central marketplaces like Landi Kotal Bazaar in Khyber districts have only two hours of average electricity. Situation is even worse for domestic consumers. Consequently, all consumers use electricity without any regard for peak load and thereby overloading the entire system which results in technical issues and system tripping. Frequent tripping at 11 kV feeders due to overloading reduces life of equipment and increases maintenance cost. Moreover, any unmetered supply removes an incentive to use it with prudence. Its common, therefore, that people tend to turn on all high demand devices to get the maximum benefit when electricity is available. Such practices include heating water with steel rods, washing and ironing clothes, and doing all these activities at the same time. Due to this reason, a sudden surge in the system creates frequent tripping issues. People are generally not aware of the technical reasons for

load shedding and hence, do not understand the consequences. There is a need to introduce technical monitoring as well as to enhance capacity building, to control surge demand and in-efficient energy practices, which otherwise, would render the current expansion plan only a futile exercise.

Weak Financial Sustainability

A successful grid electrification requires distribution companies to sustain on their own, generate revenues and muster up investments for future expansion plans. Currently, TESCO financials are not sustainable due to high dependency on federal subsidy coupled with low recoveries and high losses. Most of the development works are initiated by donor agencies and provincial/federal government support through Annual Development Plan (ADP) and Accelerated Implementation Program (AIP) which are limited and time bounded. On the financial side, TESCO faces scores of challenges ranging from weak balance sheet, accrued payables/receivables, low recoveries, and tax issues. TESCO grid is not mutually exclusive of PESCO due to which it owes liability of Rs. 37.3 billion to PESCO as of December 2019 for Use of System Charges (UoSC). The power regulator, NEPRA, has shown concerns on the continuous increase in payables to PESCO even though wheeling charges are built in the tariff to be recovered from the consumers through subsidy. NEPRA has repeatedly directed PESCO and TESCO to come up with a concrete plan to pay off this liability but little progress has been achieved. 56

There are issues related to the Federal Board of Revenue (FBR) and the application of exemption from Sales Tax on TESCO consumers. There have been disputes between TESCO and the FBR as to whether the sales tax should be charged on invoiced or collected amounts. The difference arises from technical and commercial losses over NEPRA's targets, bills to the government of some regions that do not pay their bills in full, and arrears on the subsidies paid by the government. Further, FBR delays the refund of the withheld sales tax, increasing receivables at TESCO's end. FBR in the past, has also attached TESCO's accounts on non-payments of taxes. 57

As mentioned earlier, TESCO recoveries (without subsidy) are almost non-existent from domestic consumers. For billing purpose, the dispatch at 11 kV feeder is billed to CPPA-G and GoP pays the subsidy to CPPA on TESCO's behalf. For accounting purpose, the units are billed against a consumer which is not possible without metering at a consumer level. Therefore, the amount is usually billed against the individuals registered in voter lists. The recoveries from commercial sector are also very low since shops have overwhelmingly shifted to off-grid solutions due to unreliability of electricity supply. The only positive side is the industrial recoveries that are close to 100 percent. To facilitate industrial off-take, a new model for dedicated feeders for industrial consumers have been adopted where they are supplied with 24 hours of electricity against 100 percent recovery and meterization at all outlets. Such models have been developed for high consumption industries like steel and marble and is expected to grow in coming years. 58

Weak Transmission and Distribution Infrastructure

TESCO's sub-par performance can be attributed to a weak transmission and distribution infrastructure and lack of clear strategy focused on developing an outcome-based investment plans for grid expansion. The transmission and distribution systems are archaic in nature, heavily loaded at critical Common Delivery Points (CPDs) and 11 kV systems and merit investments to prevent further supply bottlenecks. Network bottlenecks, with many sections substantially loaded above their stipulated ratings, and low voltage capacity have prevented the addition of new loads. Distribution systems have become the holdup and frailest link of the TESCO power network, and faces constant overloading and voltage drops. In FY2020, it was reported that 79 percent of 11 kV feeders and 35 percent of distribution transformers were overloaded. Further, investments have not been anchored on long-term plans for generation, transmission, and distribution systems, keeping in mind the needs and wants of eventual consumers. The end consumers need heating and lighting instead of 11 kV lines submerged under operational inefficiencies. Currently, the demand for TESCO consumers stands over 800 MW, out of which only 252 MW is being supplied for 4-6 hours. The weak infrastructure bottlenecks can be attributed to three major areas; Weak transmission network, outdated high voltage distribution network, and absence of low voltage transmission lines. 59

Lack of LT Network

A usual practice followed in MAs is to have multiple nuclear families, of a joint family system, forming a single household. They tend to live in separate settings within a single boundary wall. Since TESCO do not own or sponsor the LT network infrastructure, such households buy their own transformer, as shown below, for stepping down voltage. The low-quality sprawling transformers like this offer high resistance and consequently, high losses to distribution network.

One of the major operational bottlenecks is the weak transmission network where there are not enough interconnections with NTDC network. Currently, High-Tension (HT) lines are operated through NTDC and each DISCO is essentially dependent upon NTDC network from where they supply electricity at 220/66/32 kV system and down to 11 kV feeders followed by step down transformers at street level. Since TESCO was decoupled from PESCO in 2011, the TESCO distribution network depends on its interconnections from PESCO as an upstream power transmitter as compared to NTDC directly. TESCO currently have only one interconnection with NTDC at 60

Khyber Agency, whereby the rest of the grid stations are extended from PESCO grid network. Moreover, even the interconnections from PESCO grid originate from areas of PESCO which themselves are overloaded with unreliable electricity. The low number of interconnections and linear distribution topography of TESCO grids results in weak transmission grid infrastructure with low resilience. There is a risk of grid dependency on only one transmission line, and hence if there is an issue in upstream transmission line, the grid operator has no other back up transmission line to which load can be shifted to.

61 Another bottleneck is an outdated transmission line technology. Even though the world is moving towards advanced distribution technologies to reduce losses, TESCO grid is outmoded and is still using conventional 66 kV system for long distances which increase losses. TESCO grid is still operating on 66 kV Grid Stations (G/S) which result in higher losses. Additionally, 66 kV Grid Station maintenance parts are not readily available and hence require in-house maintenance which affects the quality of repair work due to limited in-house technical capacity. Another issue with distribution line topography of TESCO is that 11 kV Grid stations are too far apart, and feeder lines run too long. A typical feeder line is supposed to feed within 30 km range after which there is a need for new Grid Station. However, in TESCO's case, this distance sometimes increase over 100 km before any new grid station is available. This scarcity of grid stations and long feeder lines also add to system losses. Moreover, the 132 kV grid station that exist are mostly shared by PESCO and TESCO. This in turns makes it difficult to separate PESCO consumers from TESCO in that vicinity. TESCO consumers are subsidized and billed at feeder level, therefore in absence of bifurcation of such feeders, it raises questions if PESCO's losses are overlapped with TESCO and vice-versa, since there is no physical way of differentiating between the consumers of the two DISCOs in such feeders. Another bottleneck is the absence of Low Voltage Transmission Line Network of 220/440 V, which is stepped down from, High Voltage Transmission and Distribution Network, before reaching the end consumer. This stepping down is ideally done at single or multiple street levels, with typical transformer serving about 10 households. TESCO do not own this kind of low transmission network, and in fact the consumers themselves have installed private transformers at household level. The decentralization of transformers results in sprawling and unplanned extraordinary number of transformers which is a high loss machine itself. Consequently, the overall losses due to transformers is on increase. Replacing the multiple transformers with a single unit and shared equipment could reduce losses in copper wires and help in managing load. Moreover, since every households have their own transformers, there is little or almost no accountability on efficient use of LT system. This ultimately results in inefficient usage and network overloading.

Weak Corporate Governance

62 Good corporate governance is key backbone of any company to improve accountability, business performance, employee retention and shareholder value. It encompasses several features such as the composition of the board of directors and its respective committees, oversight of management, compliance, and compensation practices. The unbundling of WAPDA into DISCOs back in 1998 was based on strategy of operating distribution companies based on corporate governance rules as part of reform plan for opening electricity market. Unfortunately, the basic practices and requisites of Corporate Governance have never been fully implemented at TESCO. It faces multiple challenges regarding corporate governance leading to reduced transparency and operational inefficiencies.

63 The foremost issue is the formulation of a capable, independent, and autonomous board that could provide oversight and direction to TESCO operations and investments. Even though TESCO was issued a generation license in 2013, its Board of Directors (BOD) was never formed. There are no independent directors, which leaves vacuum for accountability, procurement, and performance regime. Generally, appointing members of board of directors is carried out by the federal government. In the past, political considerations have guided such nominations, reducing the independence of directors, and limiting transparency and public outreach. In the absence of a BOD, the company lacks the two most important independent committees that can ensure transparency, audit, and compensation committees. The statuary auditors should be accountable to these committees as opposed to CEO of the company.

64 Another important area is the lack of automation, such as an ERP system and a modern financial bookkeeping standard. Efficient bookkeeping and optimized resource planning are crucial requirements for successfully running a company. The significance of this becomes more important when it comes to a financially struggling organization like TESCO, where the focus should be on making the maximum use of scarce resources available. One of the consequences of weak corporate governance along with lax accounting and bookkeeping standards is a large unfunded pension liability. Public pension schemes have long been identified to generate major social and economic implications for organization and its workers. Creation of funds ensure that the company records its liability more prudently as the funds are transferred to a separate legal entity. In addition, these independent funds generate their own profits if kept separate from the company's routine operations. TESCO has not developed a pension fund despite recurring requests form NEPRA. In the absence of such funds, it raises questions on TESCO's capacity to pay pension liabilities. Currently, these liabilities have accrued up to Rs. 243 million with no tangible plan going forward as how to fund and pay them.

Lack of Clear Transitional Path Post FY2023

65 Electricity, like any other commodity has a cost associated with it, and to expand electrification, the whole cradle to grave life cycle of electron needs to become financially sustainable. This implies that electricity cannot be distributed freely and must be accompanied by at least some cost recovery tariff. However, within MAs the Federal Government has exempted payment of electricity bills along with the payment of natural gas bills and zero taxation till FY2023. Essentially, local communities have not showed willingness to pay, and their stance is further strengthened by a sub-par electricity supply of 2-3 hours, which is not worth paying anything at all. In such a scenario, there is lack of a clear transitional path post FY2023. The domestic sector recoveries are most difficult due to existing mindset of not paying for electricity at all, which people considering it as one of their constitutional rights. Moreover, this consideration of electricity as a free commodity results in an inefficient load management practices leading to uncontrolled demand and constrained grid. What is needed is a clear transitional path post FY2023, outlining how much electricity will be supplied, at what cost and to which segments? How will the meterization strategy be pursued? And at which scale? And the entire strategy certainly requires a rigorous communication plan, which needs to take into confidence local communities of the benefits of paying in full and receiving optimal electricity in return.

Other On-Grid Challenges

66 In addition to challenges mentioned above, electrification through TESCO faces following broad challenges, based on key insights obtained from stakeholder consultations and data analysis.

Table 4: TESCO key challenges

S.#	Challenge	Description	Consequence
1	**Delayed disbursements of AIP.**	Although the very rationale behind initiating AIP is to accelerate the development works, the disbursement to TESCO for current financial year still has not been made.	Delays in development works; impedes prudent management of TESCO cashflows.
2	**FBR Taxation Policy**	TESCO is not liable for paying any taxes to the government due to the exemption given to its consumer for 5 years but FBR still claims for sales tax on units sold. An additional liability of Rs. 3.4 billion have been given to TESCO by FBR.	After issues of notices, FBR has removed TESCO from its Active Taxpayer List. FBR also froze accounts of TESCO for non-payment of taxes in FY 2016
3	**Staff shortages**	There is a shortage of technical staff. Recruitment procedure is complicated and time-taking. Out of 2,500 sanctioned positions at TESCO, approx. half is only filled.given to TESCO by FBR.	At least 6 people are required on a grid station but less than half are available normally. The consequence is weak field formations with limited ability to cater to technical on-ground challenges.
4	**Security Situation**	The law-and-order situation have improved but there are still concerns, especially for the North and South Waziristan regions where security concerns impede project execution.	Poor law and order hinder mobility and require support from law enforcement agencies. It also, delays maintenance works as some areas are still not safe to travel at night or without escort.
5	**Insufficient Operational Facilities**	TESCO lacks major operational facilities and infrastructure as compare to other DISCOs. This includes cars for travel and human work force.	Affects mobility for maintenance and operations. Also, affects delays in completion of developmental works.

Off Grid Electrification Challenges

Apart from the grid electricity challenges outlined above, there are also tangible off-grid electrification challenges also and are outlined as below.

Proliferation of Low-Quality Products

67 One of the major impediments against successful distributive generation is the sprawling low quality solar products MAs. Almost all the homes have solar system but almost all of them have low quality products (for as low as 30 Rs/watt) compared to high quality product (around Rs. 100/watt). Additionally, the paying power of people is quite low which makes upfront investment on these high-quality products, unviable for public. However, the data analysis shows that the cost spent on other issues like fuelwood and replacement of the system, the high-quality system becomes competitive and even a better option in longer term. The low-quality panels last for about 2-3 years as compared to high quality panels that come with a performance guarantee of 20 years. Situation is grimmer with batteries, as people are still using lead acid batteries for solar system which are usually refurbished locally. However, the battery life is as low as 1 year, in contrast to high quality gel batteries which may run up to 5 years. The actual battery life of course depends upon the discharge cycles. Public interview assessment showed that people buy new or refurbished batteries every new season before summers. One such 200 Amps battery cost around Rs.15,000-20,000. However, the refurbished battery having a lower life is much less costly. The presence of poor-quality products is the biggest challenge, as it sets all the wrong trends affecting consumer trust issues. Additionally, these products are remarkably cheaper, due to their sub-standard quality, which makes them more attractive for public who is unaware of the consequences. Based on stakeholder consultations, Pakistan alone imported around 1.3 GW of panels in 2019, out of which only 30 percent share was of tier 1 brands and the rest included were through informal and small SMEs import.

Low Quality Solar Systems

The SHS system in MAs is sold on equipment-by-equipment basis as opposed to a complete system by a specific installer. There are shops for panels and batteries, as shown below, from where people buy equipment and then ask electrician to simply connect them. The result is lack of ownership by wither the retailer or the installer. Below picture shows one such retailer in Jamrud Bazaar of Khyber Agency. Ground consultations also raised an essential consequence of low-quality products which includes frequent disputes among shopkeepers and consumers. Such disputes happen almost on daily basis and often revolve around the promised product versus the actual product.

Inefficient Use of Solar PV Systems

68 One of the major issues of SHS is its inefficient use which not only prevents the optimum utilization, but also create maintenance and operational issues. General practice followed is to buy panels and batteries and ask local electrician to simply connect them without any ancillary infrastructure like charge controller and circuit breakers. The result is a low-quality installation of a system with no one responsible for the O&M. Such system also faces multiple challenges as outlined below. The first issue is the lack of maintenance. Research suggests that a uniform layer of 10g dust accumulated on solar PV module can reduce its power up to 25 percent and when module is accumulated uniformly with 50g of dust then power is reduced approximately 55–63 percent. Almost all the panels on the roofs were layered with thick dust layer and people generally remained unaware of the importance of cleaning solar panels, especially in areas which are surrounded by barren, rocky and dusty mountains.

69 The other issue is a non-optimum angle of panels, which is quite important to get optimum production. The optimum solar angle for panels is 25 degrees for Pakistan. The field visit showed that most of the houses had panels laying horizontally flat on the roof. Some commercial shops even had them placed in front of shops with people passing by and creating shadow effects. Such practices lead to low utilization of production potential of solar panels. Third, another key issue raised by solar retailers is the problem related to short circuiting of equipment. People generally tend to misuse the system and unintentionally short

Maintenance of SHS

The field visits showed to us that although solar systems are ubiquitous in entire MAs, there is no focus on maintenance aspects. It is evident from the picture below from rural setting near Landi Kotal bazaar of Khyber Agency. The rooftop solar panels could be seen covered with thick layer of dust. Except few, most of the panels are lying flat on the ground without any solar inclination angle for optimum use of solar. Ground consultations and interviews revealed that people are generally unaware of the maintenance practices required for solar panels.

circuit it. Most of these systems lacks any kind of tripping mechanism due to which it directly affects the equipment, specifically batteries. The short-circuiting renders batteries useless which consequently becomes a reason for dispute when the customers ask for a return. In proper solar systems, such practices are avoided by fixing connection and using tripping mechanism to save the equipment. Last, there are issues related to overloading of systems. Apart from low quality solar systems, there have been some mainstream developers providing top quality, tier-1 solutions to high end users. These developers often complain of system overloading, creating tripping issues and affecting the whole lifecycle costs generally because people tend to misuse the system unintentionally by adding unwarranted load. In the absence of training, any resulting issues create distrust among public for high-quality products.

Weak Infrastructure for Hybrid Solutions

Another challenge identified by solar developers is the weak infrastructure for on-grid hybrid solar solutions with battery backup and grid connectivity. The most cost-effective solar solution is the hybrid system, since it need lower battery backup and hence lower cost as oppose to off grid system that requires large battery banks. However, such system needs to be complemented by reliable grid connectivity for their successful operation. One of the foremost issues is low voltage of the grid. Distribution systems have become the holdup and frailest link of the TESCO power network, and faces constant overloading and voltage drops. The results are an unreliable and low-quality supply to SHS where either the voltage is too low, or the frequency is not optimal. This affects the equipment which require grid input at certain voltage and frequency. Consultations with private developers operating in MAs revealed that sometimes the voltage is as low as 100 V as compared to nominal 220 V. Stabilizers and voltage regulators are used to overcome this problem. However, the prolong and acute low voltage may even render regulators and stabilizer not useful. This is then often compounded by the issues of load shedding. For MAs, SHS require large battery backups considering long duration power blackouts. This results in unwarranted expenses to have battery backups of 24 to 48 hours, which consequently increases the solar system costs by many folds. Moreover, the consistent load shedding makes it impossible for the batteries to completely charge in cloudy days which ultimately further increase the battery size. 70

Regulatory Impediment Through DISCOs

High solar irradiance, lack of grid infrastructure, and public acceptance of solar solutions are key criterion for distributive generation through mini grids. All these characteristics are available in abundance in these areas and makes it an ideal location for distributive generation setup for mini and micro grids. However, the current regulatory regime remains a bottleneck as NEPRA has provided an exclusive license to TESCO as the sole distributor of electricity in MAs. Any new entrant on the supply side is thwarted by distribution exclusivity provided by NEPRA to TESCO until 2023. There is a need to open the market, allowing other private entrants to come and provide for mini-micro grid solutions to close knit communities, which otherwise would not be possible if left alone to TESCO. There is successful example in Gilgit Baltistan, where in some areas, GIZ and kfW sponsored run-off-the-river projects for local communities through microfinancing model and have provided much relief which would not have been possible otherwise through distribution monopoly. Such models can be implemented after 2023 when the distribution exclusivity will expire. 71

Other Challenges

There are other miscellaneous challenges, as summarized below: 72

Table 5: Other challenges

S.#	Challenge	Description	Consequence
1	**Access to market**	The security situation and access to markets come out as key logistical issues in deployment of off grid solutions. There is a potential for Tier-1 modular products, however, the market remains untapped as the private players have found access to key markets difficult.	Long travelling time results in delay in maintenance when required. The only market players in place are those with existing networks such as fertilizer, banking and DFI companies.
2	**Access to finance**	With low propensity to pay, there is a need to develop new financing models, such as access to affordable finance. Current solutions present in the market offer high micro-financing rate ranging from 30 – 55 percent.	Limited access to finance and cost associated with developing distribution networks and opening field offices remain high.

Key Recommendations

73 Public policies are formulated and implemented keeping in mind the intersection of markets, technology, and people. However, when centuries old public policies become rigid or unable to evolve, public policies do more harm than good. Markets become devoid of reality and operate in isolation, old technologies are used limiting an opportunity to leapfrog and most importantly, people's needs are ignored, creating further political alienation.

74 Today, the public policy for merged areas electrification is facing a disconnect. More than a century old commercial, legal, and technology centralized grid operations is being deployed without considering its 'cost-benefit analysis'. Decades of emphasis on the central station model of electrical supply, transmission, and distribution are reflected in policy, governance, and regulations. Further, all funding and operations are centred around TESCO for construction, siting, cost allocation, tariff recovery, and subsidies. The results are negligible improvements for end users who continue to live in energy poor conditions. The “public interest” in the public policy remains missing.

Rethinking Electrification

75 It is time to rethink electrification strategy for merged areas. Government has been providing free electricity to domestic consumers for which it pays annual subsidy to CPPA against units supplied. However, eight years down since TESCO's incorporation, the results show a dismal picture. Overall, communities are not satisfied with low-quality electricity, TESCO struggles financially, and Government is burdened with an annual subsidy burden without a way forward.

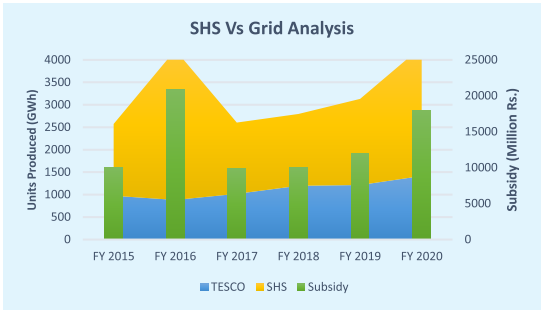

Figure 10: SHS vs grid analysis

76 Today, few questions require attention. What if, instead of spending all resources on unsustainable grid practices, we develop a new economy distributive generation model? What if such a model is government driven? What if subsidies are targeted to better provide energy at the end use level? What is the way forward post FY2023? And how electricity can be provided to increase employment, to power schools and hospitals and the future development agenda of Mas?

77 A simple analysis shows that TESCO dispatched 6,695 GWh of electricity to domestic consumers in the last 5 years, using a total subsidy amount of Rs. 80 billion. Diverting this subsidy to high quality certified solar system installed for the same subsidy amount would have produced 12,923 GWh Units – almost twice of what TESCO delivered through the grid. Had we taken that route, consumer welfare would have certainly improved, TESCO would have had more financial security, Government would have had less fiscal risk through continuous subsidy provisions, and overall development agenda would have progressed better. It is time that policy makers re-think the electrification policy and institute a lasting change management program.

Path of Action

78 For merged areas, it is time to re-define public policy objectives with three simple questions: What is the objective of providing electricity to end consumers and at what cost? Which barriers must be overcome? And how a socio-economic agenda be achieved through provision of reliable electricity? In a broader sense, it is time to debate and arrive at a consensus on electrification policy goals before articulating a regulatory framework to achieve them. Through this study, we will propose six major goals for electrification policy and then summarize a path forward to achieve them. The six goals are as follows:

1. Rethink domestic consumer electrification strategy. Domestic consumers are currently receiving 2-4 hours of electricity from TESCO, harming their socio-economic potential. It is time to reduce their dependence on grid supply and rethink a more distributive supply source – one that is already prevalent.

2. Promote social agenda through renewable energy. Merged areas need electricity for upliftment of schools, hospitals, and community centres. A concerted effort is required to promote electrification strategy for social development.

3. Improve grid infrastructure for industrial supply. Employment opportunities and presence of electricity go hand in hand. It is vital to improve physical infrastructure for TESCO to complement and enable industrial off-take for improved employment opportunities.

4. Minimize health, gender, and environmental harm. People in merged areas continue to use kerosene, wood and biomass, resulting in hazardous health and environmental impacts. There is a need to apply appropriate and cost-effective innovation to reduce health, gender, and environmental impacts of energy poverty, while maintaining affordability and reliability.

5. Develop new energy economy models for consumers not connected to the grid. There are more than forty (40) percent villages not connected to the grid and it is important to devise a plan to provide them with cleaner, reliable electricity access. Both the federal and provincial governments can include new technologies that can enable achievement of electricity through public sector investment in research, development, and demonstration (RD&D).

6. Reduce reliance on fiscal support through transition from current subsidy regime. The federal government has invested more subsidies in TESCO than what it could have invested to achieve higher electrification rates through solar deployment. It is time to forge a path, which is fiscally responsible, removing the burden on federal government subsidies to the one that is financially viable and fiscally responsible in the long run.

The primary recommendation is to rethink electrification strategy beyond TESCO's operations and capture market efficiency and competition by integrating distributed resources. In today's times, policy makers can help erect a vibrant, fair, and an equitable market for distributive generation that can supplement grid electricity. The pace of progress can easily be accelerated through deployment of linear, non-expansive, solar based technologies, initially through SHS and later, through mini-micro grids. One also must recognize that distributed resources, which have not appeared useful ten years ago can squarely address the needs of customers by providing them the best electricity services at the lowest cost and without burdening the fiscal risk. What we have learned from this diagnostic is that end users in merged areas understand solar energy, knows the basics well enough to operate it, are willing to pay a premium for reliable electricity and have developed an on-ground mechanism to repair, operate and maintain the technology, all by themselves and without any outside intervention. 79

If a rethink for distributive generation is adopted, one can witness many winners in the region. The overall society would prosper because electric service could be provided on-ground, at lower cost and with higher reliability. NEPRA would achieve its objective of fair and competitive electricity markets. The industrial consumers will flourish, with improved system resilience and higher reliability. The federal government will benefit from a reduced fiscal risk exposure along with political mileage among their constituencies. TESCO will benefit through a higher return on assets since it will service well-paying industrial and commercial consumers. Indigenous people will thrive since there will be a market for solar repair, maintenance, and ancillary services, attracting capital and creating jobs. Schools, hospitals, often so neglected, will function again whereas environment will benefit from lower air pollution, less deforestation and health hazards of using kerosene and biomass. The benefits will be widespread and will accrue across the value chain. 80

If the status quo is maintained, there will be tangible losers, especially those who will resist technological change and erect market barriers. TESCO, for instance, would continue to operate on subsidies and will continue to create stranded costs ("stranded wires, grid stations"). Federal and provincial governments will continue to fund energy poverty through subsidies, which will create fiscal risks without improving grass-root conditions. Local people will continue to show political alienation whereas chances of development, employment creation and social equity will remain negligible. NEPRA will continue to fund annual revenue requirements of TESCO, though no visible improvements will be witnessed. And last, industrial consumers will continue to operate in a constrained market environment with little opportunity to expand frontiers of their commercial enterprise to far and wide markets. 81

Key Entry Points – Off Grid Electricity

The key entry points from this diagnostic have been as follows:

Understand the Scale and Size of Electricity Consumption

There is a disconnect between what is being supplied by TESCO and what is required by the population in merged areas. There are diseconomies of scale and perhaps a more concerted effort is required to understand the needs of the end users and what form of electricity they should be supplied with. There are enormous differences between the scale of most energy (especially electricity) uses as we found through our survey. For instance, most of the end users require mere lighting, fans and mobile charging **(refer to Annex-C for survey findings),** which does not require elaborated engineering through grid electricity. 82

Most of the end-use devices important to daily lives in merged areas require 10^{-1} to10^{3} Watt (such as portable radio, handheld cellular phone, television, LED lights, fans etc.) and are clustered within living or working units requiring 10^{3} to 10^{5} W. Most production processes of practical interest can and should serve of roughly that scale and solar PV remains an ideal technology for this. In the long run, energy systems based instead on efficiency, appropriate technology, and providing energy at the right quality and scale for each end-use task would work better and cost less for the government. 83

In this context, both the federal and provincial governments can partner with The World Bank (WB), which is supporting Pakistan's energy sector through a multi-year Programmatic Advisory Services and Analytics (PASA) activity titled "Pakistan Sustainable Energy Program". The activity aims to support the energy transition in Pakistan so that the sector becomes more financially and environmentally sustainable. The PASA has recently expanded to include a pillar of work to help the Government identify solutions to achieve national electrification 84

and tackle persistent gaps in access to modern energy in Pakistan. The National Energy Survey aims to get a more granular picture of the current access to electricity as well as the willingness and capacity to pay for electricity. Also, the World Bank, in consultation with multiple development partners, has developed the Multi-Tier Framework (MTF) to monitor and evaluate energy access by following a multidimensional approach. The Government can request for a similar comprehensive study to improve the measurement of energy access, by going beyond the traditional binary measurement of energy access—for example, having or not having a connection to electricity, using or not using clean fuels for cooking—to capture the multidimensional nature of energy access and the vast range of technologies and sources that provide energy access, while accounting for the wide differences in user experience.

Action Tip: Conduct a comprehensive feasibility / use case survey on merged areas end user electricity needs and how best these needs can be fulfilled. The technical feasibility can provide grid electrification status, household listing activity, micro-enterprise listing activity and technological tools available to meet electricity needs (for instance, grid versus SHS).

Optimize Off-grid Financing Arrangements

85 Merged areas are perhaps the most solarized region in Pakistan, with every home having a stand-alone solar home system. Regardless, the area remains void of progress and industrialization, which could be largely attributed to the low-quality solar systems owing to low paying power of people. Our analysis indicate that people often end up paying more for low quality systems considering the life cycle cost comparison versus high quality systems. However, the banking sector contribution or government interventions through suitable financing models could bring high quality SHS to public reach. Government should consider developing an enabling environment through suitable financing mechanism, like green banking guidelines of State Bank of Pakistan (SBP).

86 Considering the widespread use of off-grid solar energy, it is recommended to study and implement a financing model to improve its off-take. The evolution of pay-as-you-go (PAYG) technology has revolutionized energy delivery to people (refer to Annex D - Literature Review). But the dominant PAYG off-grid solar business model represents unique financing challenges: how do off-grid solar developers can maximize growth with substantial capital tied up in receivables from low-income communities? Which innovative financing instruments and channels are suitable for off-grid solar developers? The nature of these vertically integrated business models, operating across a range of countries, adds to the complexity. The off-grid solar sector and its value chain bring unusual financing challenges. Unlike traditional retail business models, the dominant off-grid solar business model is asset-heavy (high upfront costs), service-heavy (regular upkeep and maintenance), and consumer finance–heavy (comprising of significant portion of monthly incomes). There is a need to develop a suitable transaction structure that can provide access to finance in the most transparent fashion.

87 To institutionalize a financing mechanism, the Government can undertake a project finance structure through Federal Public-Private Partnership Authority (P3A). It can engage financial and transaction advisors to conduct rigorous analyses to ensure Value for Money (VFM) and cost-benefit analysis for a potential viable project for Mas through off-grid solar. The transaction can include segments on project management, estimates of life cycle cost and a viable financial structure to benchmark service delivery using public money through Viability Gap Funding (VGF), and including an analysis of estimated achieved operational efficiency gains. The project can be designed under two phases:

88 Phase I – Transaction design: This phase requires evaluation of specific project-wise technical, financial, economic, institutional, and legal feasibilities for SHS off-take in MAs. The transaction technical consultants can support P3A and federal government to conduct due diligence, review technical viability of proposed dissemination and establish an economic and financial sustainability through financial modelling, analysing sources of finance and the need for subsidies available through either own VGF or multilateral support.

89 Phase II – Transaction implementation: Managing competitive transaction process would require on-going support, from promotion to contract award and all the way to financial close. Once a transaction structure is approved for marketing, Government can support provincial agencies to gather and organize information and documentation pertaining to this project in a secure data room. The transaction advisors can consequently support bid document preparation, with essential information that potential private developers need for making a preliminary assessment of the projects and a complete RFP package including biddings rules and evaluation criteria in liaison with federal counterparts. The team can also support local project promotion campaigns to ensure robust competition for near-term partnerships, including roadshows with the participation of all relevant government stakeholders. Last, the P3A team can assist in managing the bidding process, including all stages from pre-qualification through review and evaluation of technical and cost proposals to negotiations and financial close.

Action Tip: Divert current subsidy to TESCO (to the tune of Rs. 15-18 billion per annum) to a more vibrant financial structure through a public-private partnership (PPP) regime using Federal P3A to lead, analyze and optimize merged areas electrification project of off-grid solar through a sound financial structure and M&E practices, including the use of independent engineers and independent auditors.

Introduce New Environmentally Friendly Technologies

One of the important needs of the people in MAs is heating and cooling. The traditional use of heating (putting hot rods in water tanks) is both inefficient and energy intensive. It also fulfils the requirement for couple of hours a day only, giving an incomplete solution. Considering harsher climates in merged areas, there is a need to introduce newer technologies such as the use of solar hot water geysers and solar cook-stoves. 90

As per this diagnostic, heating accounts for a large portion of household energy use. Solar water geyser is an excellent source of renewable energy: its fuel is free (sunlight), is infinite, and leaves no carbon footprint when converted to end use energy. Similar to the solar cooker, solar geysers present a window for opportunity to facilitate general population. It can also help in mitigating the overloaded transformers as most of the people have made immersion rods and have connected it directly with the wire coming from the transformer without any circuit breakers or switches. This causes excessive load on the transformer leading to more losses and ultimately less energy accounted for. A conventional immersion rod of 1.5 kW consumes up to 9 kWh of electricity in the time span electricity is available to the residents. This translates to a cost of Rs. 131 per household per day using average domestic tariffs. If the cost is diverted to a solar geyser, having a total cost of Rs. 26,700, the full amount could be paid off in around 200 days, with no further cost of electricity to be borne by the consumer pertaining to heating water. This proposition could be a win-win situation for all the stakeholders involved as this could also increase the time taken by the water to cool down in the solar geyser owing to its insulation. 91

Similarly, there is a palpable case for solar cookers. The geographical location of MAs is ideal for solar appliances and solar cookers can be used as a substitute for firewood. A small analysis indicates that a household of around 5 members consumed 5 bundles of firewood on average that translates into Rs. 135 per meal. This sums up to Rs. 405 of daily expenditure of firewood, assuming three meals a day. However, if a solar cooker is placed in place of the former, and we assume that the solar cooker is only used for cooking lunches, an expected payback of 166 days can be anticipated. The consumers, instead of paying Rs. 135 for firewood, can pay for the solar cooker on a daily basis and would be able to enjoy a payback of five to six months. The biggest incentive is that the people would not need to spend on energy costs for food later on and would also save up their expenses by Rs. 135 per day. The solar cooker requires minimal maintenance and hence does not require any hefty operating expenditures. 92

Action Tip: Introduce newer energy products for cooking (solar cooking) and heating (solar geysers) for an improved energy access, environmentally friendly outcome.

Awareness Campaign for Optimum O&M of SHS

One of our key findings from consultations/interviews/surveys is the underutilization of energy resource potential with almost no focus on energy O&M practices. Overall, there is little connection between awareness of the existence of PV systems and education, age, income, employment, or occupation and people remained largely unaware of how best to use the solar system. The awareness of the existence of PV is not the same as the awareness of the functioning. Following the low awareness of the functioning of PV, the awareness of product quality is also low. Although brand names of components (such as batteries, invertors etc.) are used for quality assurance, this is not sufficient for the users, especially if they have no idea of the importance of matching components within a system or how to tilt the panel to optimum location or as simple as cleaning the solar system. Negative experiences with inferior systems have damaged the reputation of PV technology and have often resulted in perceptions that technology is inferior quality. Although good quality components may be available, modules are often undersized compared to the rest of the system and almost all panels continue to soak dust. 93

What we have noticed is that the off take of SHS happened because of the word-of-mouth marketing and demonstration. To facilitate demonstrations, local technicians demonstrate lighting systems to other households, who install them in their own villages and use them as exhibits for further demonstration. What we believe is that same demonstration impact could be used for education and training and creating general awareness of potential customers. The majority of customers remain unaware and did not know that maintenance is necessary. The challenges regarding maintenance and operation of SHS could be addressed by initiating awareness campaigns focused on optimum use of solar panels. Such campaigns should be focused on developing public mindset of generating maximum benefit from their investments in SHS. Moreover, the general energy intensive and inefficient practices like heating water through iron rod should be discouraged. 94

Action Tip: Invest in long-term use of solar operations and maintenance best practices framework. Education and make customers aware on how best to operate and maintain their system, improving life of the system and quality of end use energy.

Explore Mini and Micro Grid Feasibilities

95 For off grid distributive generation, SHS serves lower tier loads. To look for longer term investments and projects that could sustain industrialization, mini and micro solar grids solutions for communities are essential for keeping up with the demand. The government need to set the framework for mini and micro grids deployment in merged areas. The ADP and AIP funds disbursed for rural electrification, if diverted towards Mini-Grid development, may result in a solution for which new remote areas can be electrified without adding incremental subsidy and transmission burden.

96 In many of the places in MAs, the traditional approach to serve these communities via TESCO, which is inefficient due to a combination of capital scarcity, insufficient energy service, reduced grid reliability, extended building times and construction challenges to connect remote areas. Adequately financed and operated microgrids based on renewable and appropriate resources can overcome many of the challenges faced by traditional lighting or electrification strategies . Microgrid literature emphasizes the significance of considering a diverse set of factors that affect the technical design of the microgrid system as well as the repercussions of a chosen design on its operational structure. Specifically, the “best practice” for design is that developers should not design the system based on pure technological considerations, but instead adapt to the specific social and economic characteristics of the rural community . Essentially, for any well-developed systems, the Government first need to undertake comprehensive technical feasibilities, ensuring that micro-mini grid deployment remains in sync with the needs of the communities and are designed and developed based not only as a one-off project but after thorough analysis and rigor.

97 The microgrids generally provide a range of services, from residential lighting alone to entertainment, refrigeration and productive commercial uses. Communities not connected to the grid can benefit deeply from this service instead of extending TESCO grid. Depending on the number of customers served, the types of services provided, and the type of generation technology used, the installed capacity of a microgrid can range from as little as 1 kW to as large as a few hundred kilowatts and can provide consumers electricity at the doorstep.

Action Tip: For almost 43 percent unelectrified villages in merged areas with dispersed locations and varied topography, the Government should invest in technical feasibilities of mini-micro grids, devise a financial feasibility mechanism and use PPP mechanisms for effective service delivery.

Develop a Pilot for New Economy Models

98 Electrifying rural populations like MAs at a price they can afford, while being financially sustainable without having to rely on federal government subsidies, poses a great challenge to policy makers. There are several reasons for this. The low income of many rural consumers in these agencies makes them unable to pay higher notified tariffs to cover the fuel cost, let alone capex and capacity payments. Local financial institutions in Pakistan have perceived off-grid energy as risky, with overall independent financing remains in short supply. This stunts private developers' growth and their ability to capture economies of scale or come up with new economy models to sustain financing gap. At the same time, government efforts have until recently focused on expanding grid access such as TESCO, and overall public sector support for off-grid electrification has remained limited.

99 Then there is an issue of labour productivity, which remains low and translates into lower household incomes. For these populations to lift themselves out of poverty, a process of structural reforms must take place. This will require an effort to shift the labour from employment in low-wage, low-productivity activities (usually manual labour) to high-wage, high-productivity activities (such as industrial, manufacturing and services activities). Such a transition can be developed through the growth of manufacturing and industrial sector, at places near to their homes, which help develop local value chains through which raw materials can be processed. Processing adds value to these goods, increasing the revenue generated from their sale and ultimately raising household incomes. For this to occur, the government needs to undertake specific new economy models study, mapping each community its own competitive advantages and then enabling energy access to foster the advantage into a long-term sustainable productivity increase. This is a long-term endeavour but would allow dispersed communities to play at their own strengths. For instance, one particular community may specialize in livestock production and sale, allowing energy production from bio-digesters for heating and cooling and completing pivoting the entire economy around livestock potential.

100 The new energy models will revolve the question around this: energy for what? Rural electrification on its own will not drive structural transformation . As important as electricity is for cooking, heating, mobile charging and lighting, it will not have a truly transformative effect on rural economies unless it is put to productive use. The benefit of energy-enabler economy is their ability to add value to raw materials, such as livestock development. The resulting development of local value chains drives economic development in two mutually reinforcing ways: adding value to raw materials raises revenues, and local firms increase their demand for labour, creating new job opportunities for the community . Rural household incomes rise as a result, enabling them to pay higher tariffs to energy providers and creating a mutually reinforcing positive effect.

Action Tip: Invest in studying new energy economy models, particularly those who remain at a disadvantaged position. Understand what drives these communities economically and socially and how energy can play an enabling role in increasing human productivity while contributing to economic development.

Key Entry Points – Grid Electricity

Revisit Village Electrification Plan for TESCO

There is a need to revisit the three-year development plan sanctioned for TESCO, especially for village electrification. The Government has approved current infrastructure projects for the distribution company amounting to Rs. 10.2 billion, while further investment pipeline is being mobilized for Rs. 11.7 billion. The investment mobilization pipeline comprises of the following: 101

- Construction of new 132KV grid stations and transmission lines to be fed from NTDC (Rs. 7.2 billion)
- Construction of new 132KV grid stations (Rs. 2.2 billion)
- Village electrification (Rs. 2.3 billion)

Amongst the three initiatives, there is a need to re-visit village electrification plan by TESCO. The current village electrification plan is expected to energize nine villages but considering TESCO's weak operational capacity as well as power sector fiscal challenges, the sustainability of this initiative can fall into a rapid disarray. If current trend is any guide, any village electrification efforts will increase fiscal subsidies and circular debt with little to no improvement in end user socio-economic lives. It is therefore essential that any major infrastructure investment is analysed and assessed through a rigorous technical and financial feasibility before providing any infrastructure stimulus. 102

For village electrification, grid connectivity through TESCO would imply an exhaustive distribution network of 33/11 or 66/11 KV level and appropriate development and augmentation of sub-transmission and transmission system at higher voltage levels. This would require continuous investment. For villages, which are far-off and remote, and where grid connectivity would not be feasible nor cost effective, off-grid solutions should be studied. From a fiscal perspective, such remote villages cannot be designated as electrified till the time appropriate solutions can be found to provide electricity in these villages to meet the requirements of the definition of village electrification or where it becomes fiscally responsible to provide electricity. 103

It is recommended that the Planning and Development Department, KP in liaison with the Department of Energy can prepare and notify a Rural Electrification Plan to achieve the goal of providing electricity access to all households in merged areas. The Rural Electrification Plan should map and detail the electrification delivery mechanisms (grid or stand-alone) considering inter alia available technologies, environmental norms, fuel availability, number of un-electrified households, distance from the existing grid etc. The Plan may be linked to and integrated with District Development Plans as and when such plans become available and can be routed to the Federal Government for any subsidy allocation, if required. 104

Action Tip: Develop and formulate Rural Electrification Plan, mapping and detailing electrification delivery mechanisms (grid or stand-alone) considering inter alia the available technologies, environmental norms, fuel availability, number of un-electrified households, distance from the existing grid etc

Undertake Comprehensive Distribution System Planning for TESCO

Distribution companies work where future strategies are planned well in advance to accommodate demand growth due to either population growth or growth accruing from increased per customer from new electricity uses, such as emerging industrial activities. When new investments are planned, they are designed to serve customers to ensure cost recovery tariffs, provision for future investments and maintenance of service standards. A breakdown in any of the three components can effectively make a distribution company ineffective. 105

In the case of TESCO, an effective distribution system planning remains missing. There are key questions that require strategizing. For instance, Is TESCO going to supply domestic consumption in the foreseeable future? How long will the federal government fund its subsidies? How will TESCO deploy technical staff to the most challenging areas? How its tariff will reciprocate with changing consumer mix especially new industrial and domestic users? How will village electrification be funded? At what pace, new villages will be electrified? Answering these questions will require rigorous review and a comprehensive distribution strategy. For each customer category, a concerted, well-designed strategy will need to be put in place. 106

For instance, residential customers typically require low voltage service. For merged areas customers, their needs tend to vacillate between heating, cooling, and water heating with bulk of the load for simple lighting, cellular charging and fan needs. Service is typically provided via overhead transformers and wires. Newer developments and subdivisions are planned by TESCO staff only, which are at times devoid of end use needs. There is little data driven, analytical exercise to determine consumption estimates to predict near- and long-term demand on distribution infrastructure. On the other hand, industrial customers can be defined by function (such as., manufacturing) or scale of electricity demand. They are typically large electricity users (such as marble, steel etc.) and often require dedicated service facilities or are placed in areas developed for industrial zones (such as Mohmand Industrial Zone). Industrial loads tend to be fairly constant during the day while also resulting in higher recoveries. In contrast, commercial customers fall in between residential and industrial and is based more on function. A commercial market may use as much power as a small industrial facility. The commercial load profile 107

is typically characterized as daytime and weekday with winter heating demand in the morning and summer cooling in the afternoon.

108 Considering different consumer needs, it is recommended that a long-term TESCO strategy is thought out. The policy makers will need estimates on number, size, and class of customers to assess demand for next five years. A reserve for future growth will then need to be included, and facilities can be sized and sited accordingly. NEPRA can then ensure a fair and transparent regulatory regime for all stakeholders, including mini-micro grids. Projections of future demand will then be used to determine if customer needs can be met by shifting customers from one technology or scope of service to another.

Action Tip: Undertake comprehensive distribution system planning for TESCO, type of customers it will serve, load it will manage and investments required. A comprehensive load management strategy will pave a way forward for growth and service delivery standards in the long run.

Improve TESCO's Corporate Governance

109 TESCO remains a major stakeholder that needs to run efficiently and prudently to ensure reliable dispatch of electricity. To bring efficiency in TESCO, there is a need to strengthen corporate governance at TESCO. As per the current HR organogram, there are 124 positions lying vacant, hindering service delivery and operations. There is no BOD for TESCO for the last many years and its CEO has all the decision-making powers, reporting directly to the Power Division Ministry of Energy. In the absence of an independent BOD, there are no autonomous committees such as HR, compensation, finance and audit committees with little to no monitoring and evaluation of on-going investment projects.

110 The Government needs to improve and strengthen corporate governance, for instance i) TESCO BOD should be formed to ensure transparency and prudency in decisions ii) Pension fund for TESCO should be developed in line with NEPRA recommendations to ensure practical fund management and payment of future pension liabilities, iii) Financial bookkeeping standards should be set up with modern practices including transition to online, digital ERP finance and accounting modules as well asset tagging of all transformers, grid stations and other assets iv) Technical assistance provided to resolve taxation issues with the FBR v) Monitoring and evaluation compliance of all investment projects, including utilization, timelines and scope of work.

Action Tip: Enhance and strengthen TESCO's Code of Corporate Governance in line with the Public Sector Corporate Governance Rules 2013 (amended).

ANNEX-A Pakistan and KP Energy Sector

Introduction

111 Pakistan's power sector stands at a critical crossroad and remains under extreme financial pressure. The period of chronic load shedding (up to 5,000 MW in 2013-14), caused by technical, operational, commercial, and regulatory barriers have now transitioned into a sector that has excess capacity albeit with low demand, higher tariffs, low system efficiencies and an ever-growing circular debt (Rs. 1.9 trillion as of June 2020). To avert a looming energy crisis, Pakistan must address structural deficiencies in its power sector to provide an enabling environment for the private sector to invest in renewable energy generation to reduce the cost of generation tariff as well as make consistent investments in distribution and transmission overhaul to reduce incidents of theft. At present, Pakistan's 39,200 MW installed capacity is sufficient for the country's population of 220 million (of whom 91 percent have access to the grid). However, with losses at the distribution level of 20 percent, not all of it reaches the end-user. Today, the bulk of the government owned generation capacity is run down, obsolete, and inefficient and requires rehabilitation. Though new functions have been added, the issue of the expensive cost of supply could not be resolved. For instance, public sector GENCOs continue to run drastically on inferior efficiencies, and under some cases have deteriorated to about half of their design values . The Government Domestic gas continues to be provided to captive power plants who use it for running smaller size machines with low efficiencies and long-term, expensive contracts for RLNG import have added constraints for the system operator to manage the sector optimally. Further, end-user tariffs are not cost-reflective — together with low collection rates (92 percent), high transmission/distribution losses, theft, and technical/managerial inadequacies — render the power sector incapable of financing itself. As such, the public sector has no means to shoulder an annual $1.5 – 2 billion price tag to meet the yearly circular debt flow, as the combined cost of sector inefficiencies. To address this challenge, GoP has undertaken several reform measures such as the issuance of upfront tariffs for wind, solar, bagasse and consequent renewable energy project investments that are in various stages of execution including 1,000 MW of wind projects along with the introduction of anti-theft measures at DISCOs level such as the installation of Aerial Bundled Cables (ABC) and smart metering. However, such actions continue to remain small as compared to the size of the problem. Going forward, the GoP's investment in large- and medium- scale public-private partnerships (PPPs) seeking to expand the role of the private sector will offer a potential pathway to improving the security, reliability, and stability to the electricity network.

112 With energy as a Federal Subject, all major decision making involves the Council of Common Interest (CCI) which takes appropriate steps to reduce inequities among the provinces. All the provinces have representation in the National Finance Commission Award (NFC) which also includes the Merged Areas of KP. On the hydel side, the water sharing, and management issues are handled by the Indus River System Authority (IRSA). Conflicts between provinces might turn more severe due to additional dependency on water, growing population, and reduced availability as a result of climate change at many locations. Pakistan, being an agricultural country, is water-stressed and therefore, IRSA's proactive role has become all the more important. Also, being a downstream riparian of India in the Indus basin, water availability depends on the release of water from India. The Indus Water Treaty is governing the water distribution rights between India and Pakistan. However, issues of construction of new dams have remained a threat to water availability to Pakistan.

113 On the hydrocarbons side, the government has initiated a reform program with a focus to (i) provide higher wellhead prices in oil and gas exploration to make the country a viable investment destination (ii) signing of Supplemental Agreements (SA) with oil and gas companies to step up exploration of hydrocarbon resources (iii) give a more prominent role to the private sector in commercial activities; (iv) diversify existing hydrocarbon base with newer, cheaper and cleaner Re-gasified Liquified Natural Gas (RLNG) – mainly replacing Residual Furnace Oil (RFO) in the power sector (iv) undertaking investments in RLNG pipelines, terminals and associated ancillary infrastructure and (v) continuing its focus on policy formulation for unconventional gas, tight gas, low BTU gas and others. Nevertheless, reforming the oil and gas sector constitutes a significant challenge, as decisions have been made on socio-economic considerations. Today, a considerable disparity exists for urban consumers (mostly affluent) who are provided with cheap, piped natural gas while most of the vulnerable population relying on Liquified Petroleum Gas (LPG) and biomass for energy consumption. Further, domestic gas tariff regime requires urgent reform measures. Also, with RLNG in the system, cross-subsidies have declined from bulk consumers which in turn have built up receivables and is resulting in a rather precarious financial position for the two gas distribution companies (SSGC and SNGPL). The Un-Accounted for Gas (UFG) losses have continued to pose a threat to the system and must also be urgently addressed. In the midstream sector, Pakistan now requires a higher-grade refinery that can bridge the gap between increasing petroleum product consumption and domestic refining production. Already the foreign exchange burden from improved POL consumption outlook is showing signs of fiscal imbalances and onerous foreign exchange requirements. The port congestions continue to pose a threat to the supply chain and logistics and competition in the downstream sector requires a boost –primarily through deregulation of distribution and dealer margins.

Institutional Environment

114 Overlapping institutional jurisdiction is one of the many challenges facing energy sector governance. A large number of government entities play a role in influencing policymaking, governance, and management of the power sector, including the Office of the Prime Minister (OPM), Parliament, courts, four provincial governments, Ministry of Planning and Development (P&D), Ministry of Finance (MOF), Ministry of Energy, Power Division (PD), and Petroleum and Natural Resources Division (PNR), NEPRA, Water and Power Development Authority (WAPDA), Private Power and Infrastructure Board (PPIB), Alternative Energy Development Board (AEDB), Privatization Commission, National Transmission and Transmission Company Ltd. (NTDC), Central Power Purchasing Agency (CPPA) (G), ten distribution companies (DISCOs), and four-generation companies (GENCOs). All the DISCOs and GENCOs are incorporated under Pakistani private sector law, issue shares, have boards of directors, and are primarily controlled and managed by MWP mainly as government entities; 100 percent of their shares are titled to the president of Pakistan. While Pakistan's major independent power producers (IPPs) are not government entities, they have power generation licenses, and generate more than half of the country's electricity (62,598 GWH in FY2019) and are a vital part of the power sector. K-Electric, with an installed capacity of 2,294 MW, serves Pakistan's largest city of Karachi, and was privatized several years ago but continues to play an important role. KE remains the only vertically integrated utility in the sector having generation, transmission and distribution systems in place. To meet its capacity, KE also imports 650 MW from the national network and has signed agreements with NTDC to purchase power from three wind power plants.

115 On the hydrocarbons side, the Ministry of Energy, PNR Division under Regulations of Mines Act, Petroleum Policies 2012 (amended) and relevant Rules governs E&P activities in Pakistan. The Petroleum Concession Agreements (PCAs) and Production Sharing Contracts (PSCs) include additional supplemental regulations. Model PCAs and PSCs have also been part of the Petroleum Policies and Rules. PNR Division is mainly represented by DGPC being the primary regulator (and also as the policymaker). Whereas Directorate General of Oil (DG Oil) regulates the crude oil sales to refineries and the sale of refined products such as diesel, petrol, kerosene oil, etc. by the oil marketing companies such as PSO, Shell, Total Parco, etc. Moreover, the Directorate General of Gas (DG Gas) regulates the gas sales to Sui Northern Gas Pipelines Company Limited (SNGPL) and Sui Southern Gas Company Limited (SSGC). Oil and Gas Regulatory Authority (OGRA) regulates the pricing for both the oil and gas with the responsibility to issue the periodic price notifications.

Institutional Roles and Responsibilities

116 The below snapshot provides institutional roles and responsibilities:

Table 6: Institutional roles and responsibilities

Agency	Role
CCOE	Strategic Decisions
Ministry of Energy	Sectoral responsibility including fuel supply
ECC	Pricing, subsidy
Planning Commission	PC-1, third party role
NEPRA	Tariff, oversight (power)
OGRA	Tariff, oversight (downstream)
DGPC	Regulator, policymaker (upstream)
SAPM / Advisor	Coordination, advice
Power Division	Control, establishment, Policies, Sectoral Planning, Coord (Power)
Petroleum Division	Control, establishment, Policies, Sectoral Planning, Coord (Petroleum)
NTDC	Transmission
CPPA (G)	Market operator, Power purchaser
NPCC	Micro-planning, scheduling and dispatch
IPP, GENCO, WAPDA, PAEC	Power generation
DISCOs	Distribution
PPIB, AEDB	Project facilitation, tariff proposal
SNGPL, SSGCL	Gas transmission and distribution
DG Oil	Regulator (Oil), Downstream
DG Gas	Regulatory (Gas)
OGDCL, PPL, POL	Upstream exploration entities (public)
PSO	Downstream fuel supply (public)

KP energy sector

The energy sector in the province follows the following hierarchal structure. The Energy and Power department of KP looks after the Hydroelectric and Hydrocarbon resources in the area and controls PEDO, KPOGCL, and the Electric Inspectorate in this regard. 117

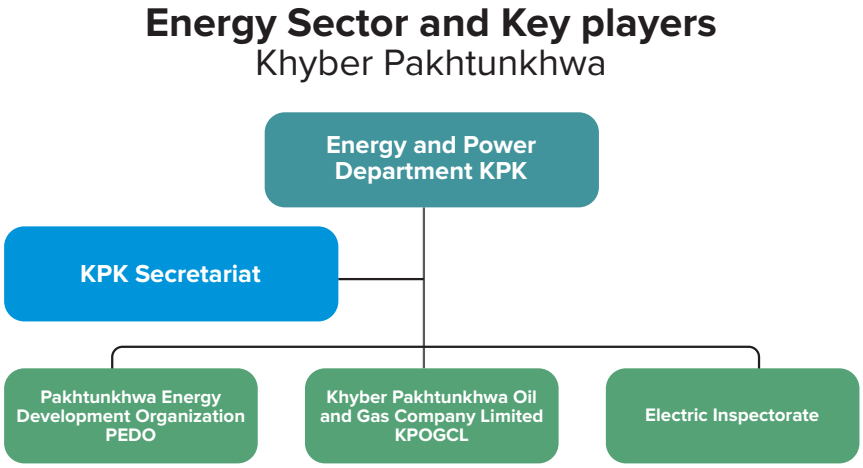

Figure 11: KP energy sector and key players

Renewable Energy

Solar wind hybrid means solar and wind energy fusion installation on one piece of Land or in adjacent sections of a solar and wind power plant. The sporadic and unpredictable capacity of solar and wind plants. Sunsets throughout the day and the wind blows in the evenings, but mostly in the summer before midnight. The winds are hard blowing in the winter in western countries, which coincide with their high demand for energy. Thus, the solar system covers a part of the maximum daily market, with wind covering night-time for the second peak. It's good for us in the heat. About 25% of the costs are said to go to Land and transmission, which is saved in the hybrid concept. In the case of individual solar and wind power projects, transmission facilities are under-use proportionately to their capacity factors – solar 17% of the time and wind 35%. The sum of the two with any overlapping parts accumulates hybrid. Thus, a capacity factor (use) of 45% to 55% is not unusual, quite a lot. The capacity factor of 45 percent is increasing in Pakistani wind farms and new technology, creating even more options, likely. Hybrid can be marketed in kilowatts Wind energy corridors in schools, hospitals, and other institutions. In tandem with the roof and the twenty-two-kilowatt equipment can be mounted here Land, and its primary benefit is the availability almost 24/7 in half of That year. The time has come for a sustainable energy strategy to be revealed in coordination with the National Electric Power Commission, the implementation board (AEDB) Authority, and other actors (NEPRA). Policies must not be heavy or noisy. There are a few things that need to be explained. But wind and solar energies are usual policy confusion, and the reported failure of the CPPA-G to respect capacity payments are after that. The reverse sale of the programs is now under consideration. This was essential to the solar and wind tariff reduction in India and elsewhere. More than 80% of KP's rural population can develop hybrid and solar-based renewable projects at a community level, given the absence of a broader electricity distribution system. They will play an essential role in reducing deforestation, improving communication, education, and health improvements for the poor. Consequently, the provincial government will implement a policy that allows villagers to communicate wirelessly. 118

While public structures federally govern most of the energy sector, the energy sector of KP is limited to Hydro Power Producers. Whereas most IPPs are in other provinces that rely on thermal power generation due to the prevalence of hydrocarbons in the areas. KP has an enormous hydropower capacity due to the significant upstream rivers such as Indus, Siran, Kunhar, Chitral, and Panjkora. The province has a combined power output of almost 30,000 MW. Most of the hydro projects under development are in the public sector and are owned by the Water and Power Development Authority (WAPDA). While public structures federally govern most of the energy sector, the energy sector of KP is limited to Hydro Power Producers. Whereas most IPPs are in other provinces that rely on thermal power generation due to the prevalence of hydrocarbons in the areas. KP has an enormous hydropower capacity due to the significant upstream rivers such as Indus, Siran, Kunhar, Chitral, and Panjkora. The province has a combined power output of almost 30,000 MW. Many of the hydraulic projects under construction are in the public sector and are owned by the Water and Power Development Authority (WAPDA). The province has an immense potential to generate more hydropower due to rivers, gorges, river tributaries, and canals with reasonable gradients and V-shaped valleys carved out by rivers. The natural environment is suitable for building dams, tunnels, and other civil works related to hydropower production. Given high energy demand, hydropower projects deliver reliable positive cash flows and strong returns on investment. Hydropower ventures also benefit from income tax deductions, withholding tax on importing equipment, and turnover tax. 119

PEDO

120 The provincial government's primary objective to establish the Provincial Electricity Development Organization (PEDO) was to have an investment arm in the power sector. Initially, the KP government invested as a minority shareholder in the private sector Independent Power Projects through PEDO. PEDO now works on a commercial basis and undertakes energy ventures on its own. PEDO's Hydropower Strategy 2016 provides some opportunities to promote public and private investment in power generation. PEDO's scope of business include:

1. hydropower, solar and other renewable energy, thermal generation and transmission and distribution.

2. micro-hydro development and off-grid solar home solutions.

121 PEDO is funding its programs under the Hydel Development Fund (HDF). The HDF was formed under the [Khyber Pakhtunkhwa] Hydel Development Fund Ordinance 2001 (Ordinance No. XXVI 2001). Since 2017, PEDO has completed 73 micro-hydro projects in 12 districts and has 73 under construction (total power of 35 MW). It has partnered with ADB in its "Access to Clean Energy Program" through result-based lending. With the assistance of WAPDA and GTZ, SHYDO has prepared a Master Plan for the Production of Hydropower Resources in Khyber Pakhtunkhwa. The Regional Power Development Plan was developed with relevant technical and financial data on the various hydropower sites in Khyber Pakhtunkhwa. Approximately 142 project sites with a total capacity of 24,736 MW were identified as having a high, medium, and a small head. Out of these, 19 projects are in operation, 27 sites are in the public sector, while tent sites are in the private sector.

Electric Inspectorate

122 The management of the DISCOs reside with the Federal government and its agencies. However, it is important to note that GoKP has established Electric Inspectorate under Section 36(2) of the Electricity Act 1910 for any consumer complaints against PESCO/TESCO regarding metering, over billing, assessment against defective meters and theft, and investigations into fatal/non-fatal accidents that the inspector may carry out against the two DISCOs as a consumer rights protection agency. For instance, whether there is a difference or dispute between a DISCO and a consumer as to whether any meter, maximum demand indicator or other measuring apparatus is or is not then an Electric Inspector, within a period of ninety days from the date of receipt of such application, can review and provide its judgment on the complaint after affording both parties an opportunity of being heard. The Electric Inspectors are also given the authority to estimate the amount of energy supplied to the consumers during such time as the meter or apparatus is not correct.

123 Nonetheless, the capacity of electric inspectors remains weak. There is no established website of the agency and it is difficult to analyze how many cases have been resolved by the Electric Inspectors during a particular year and with what efficacy. With background discussions with stakeholders, it has come to light that the role of electric inspectors in KP has been limited and that consumers don't reach out to them for complaints that they may have for a particular DISCO. There are best practices that are applied globally with respect to electric inspectors. For instance, the provincial government should model such an institution for: (i) reviewing on-going regulations on technical, engineering, inspection and other standards applicable to the electricity sector; (ii) preparing a manual based on the new regulations; (iii) training and developing local staff; (iv) arranging suitable training programs for electrical contractors and other interest groups; (v) developing processes for electrical inspection and certification; (vi) implementing processes for licensing different grades of electrical contractors; and (vii) in general organizing the entity to operate on commercial lines and fulfill its statutory mandate.

ANNEX-B TESCO Investment Profile

Electricity supply in the Merged Areas (MAs) is low due to an outdated transmission and distribution network. For a population of 5.3 million, the power supply is merely 250-280 MW on average which is enough for just 58% of villages, whereas the total demand exceeds 800 MW. 124

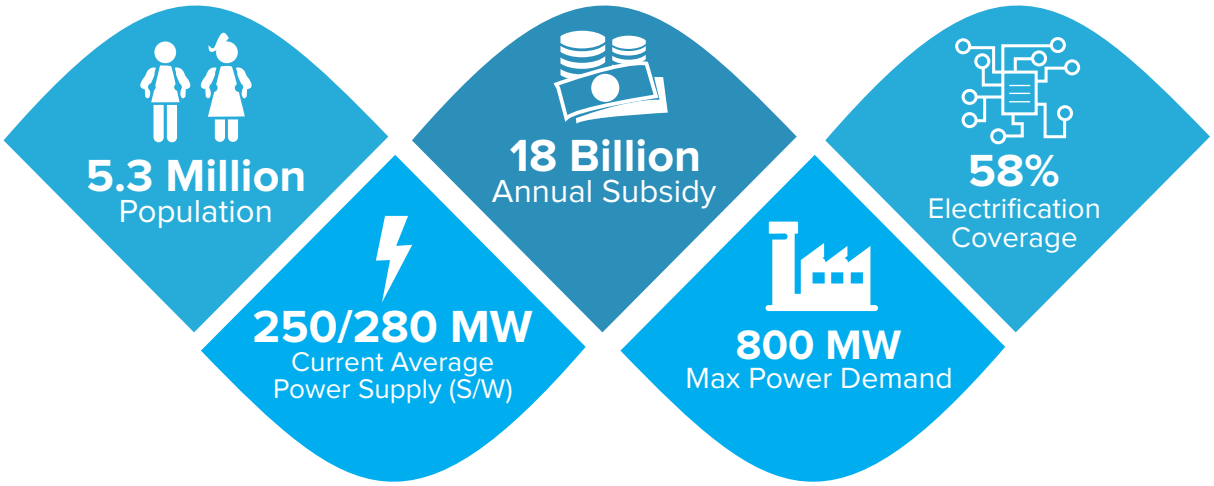

Figure 12: MAs power statistics

The Federal Government has put in motion a Rs. 10.2 billion investment plan. Currently, the load capacity of the system is 280 MW but with the improvement in the infrastructure due to on-going investment plan, the capacity is expected to increase to 507 MW. Further, with this investment plan, the village electrification is expected to increase from an existing 57% to 76% electricity coverage. 125

Project	Funding Source	
Rehab of power distribution system in Makeen & Tiarza areas (SWD)	US AID	2.9 bn
Bifurcation & shifting of 11kV feeders to 132kV G/S, Bajaur	US AID	
Upgradation of Khar G/S and T/L to 132kV	US AID	
Upgradation of Jandola G/S and T/L to 132kV	US AID	
Upgradation of Sadda G/S and T/L to 132kV	AIP	5.1 bn
Upgradation of Alizai G/S and T/L to 132kV	AIP	
Upgradation of Kalaya G/S and T/L to 132kV	AIP	
Upgradation of Ghiljo G/S and T/L to 132kV	AIP	
New / bifurcation / rehab of 94 Nos.11kV feeders	AIP	
440 Nos. village electrification schemes	ADP	2.2 bn
Construction of 132kV G/S and associated T/L, Northern Mohmand	ADP	
Addition of 132/11.5kV 40MVA power transformers at Miran Shah, Razmak and Bara G/S	ADP	

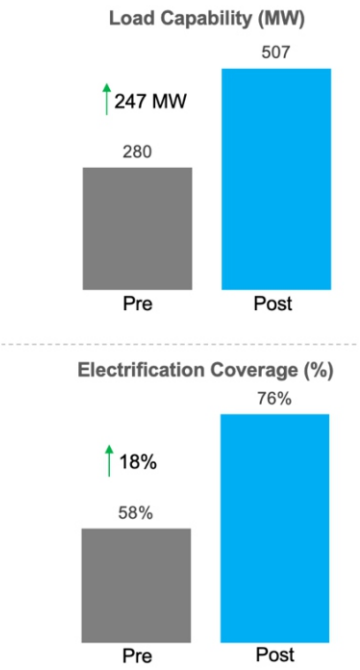

Figure 13: Federal government Rs. 10.2 billion investment plan for MAs

126 The Government has also put in motion a three-years development plan with total investment stimulus of Rs. 11.7 billion. The details of the plan are outlined as below:Figure 14: Federal government Rs. 11.7 investment plan for Mas

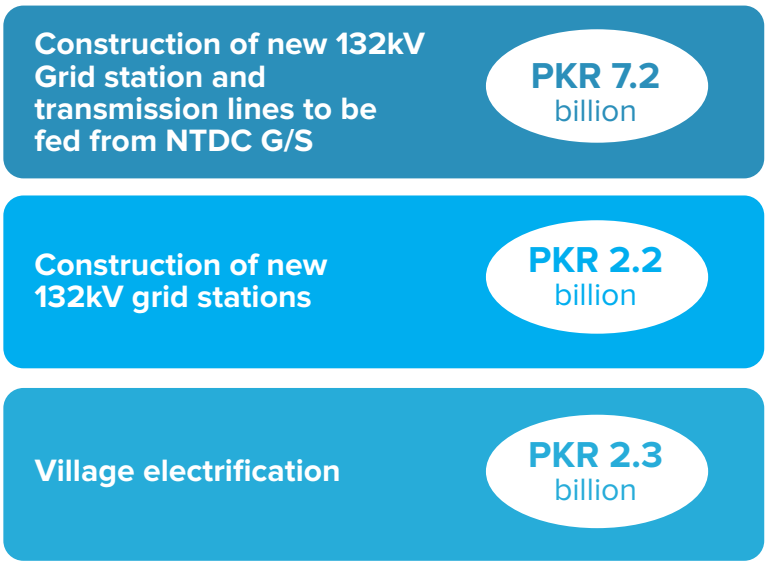

Figure 14: Federal government Rs. 11.7 investment plan for MAs

127 The project wise details of the three years investment plan are outlined as follows:

Table 7: Project-wise three-year investment plan segregation

Domain	Project	Cost (Rs. Million)	Timeline
Construction of new 132kV Grid stations and transmission lines to be fed from NTDC G/S	132kV D/C T/L from 220kV Domail G/S to 132kV Mir Ali G/S (Length= 50 km approx.)	911	June, 2022
	132kV D/C T/L from 500kV Sheikh Muhammadi G/S to proposed 132kV Darra Adam Khel G/S (Length= 35 km approx.)	1,124	June, 2022
	132kV D/C T/L from 132kV Mir Ali G/S to proposed 132kV Spinwam G/S (Length= 35 km approx.)	1,124	June, 2022
	132kV D/C T/L from proposed 132kV Spinwam G/S to 132kV Alizai G/S (Length= 65 km approx.)	1,100	Dec, 2022
	132kV D/C T/L from 220kV Shahi Bagh G/S to proposed 132kV Yaka Ghund G/S (Length= 35 km approx.)	1,124	June, 2022
	Stringing of 2nd circuit of existing SDT T/L from proposed 132kV Yaka Ghund G/S to 132kV Ghallani G/S (Length= 35 km approx.)	250	Dec, 2022
	Conversion of 66kV Mamad Gatt G/S to 132kV G/S along with associated T/L from 132kV Ghallani G/S	1,000	June, 2022
	132kV D/C T/L from proposed 132kV Mamad Gatt G/S to 132kV Khar G/S (Length= 35 km approx.)	550	June, 2023
Construction of new 132kV grid stations	132kV Mulaghori G/S along with associated 132kV T/L	589	Dec, 2021
	132kV Akakhel G/S along with associated 132kV T/L	569	Dec, 2021
	Addition of 40MVA power transformer at 132kV Parachinar G/S along with stringing of 2nd circuit of T/L from 132kV Sadda G/S	349	Dec, 2021
	Augmentation of 20/26 MVA power transformer by 40 MVA power transformer at 132kV Mattani G/S	160	Dec, 2021
	Augmentation of 20/26 MVA power transformer by 40 MVA power transformer at 132kV Hayatabad G/S	160	Dec, 2021
	Addition of 40MVA power transformer at 132kV new Jamrud G/S	160	Dec, 2021
	Addition of 40MVA power transformer at 132kV Khar, Bajaur G/S	160	June, 2021
	Extension of Control house buildings of 132kV Ghallani and Khar G/S	50	June, 2021

Village electrification	Electrification of Works at Ambar, Safi & Khwaizai Baizai Area Tribal District Mohmand	250	June, 2022
	Electrification of Works at Shawal Area Tribal District North/ South Waziristan	330	June, 2022
	Electrification of Works at Santoi, Mantoi Area Tribal District South Waziristan	320	June, 2022
	Electrification of Works at Bazar Zakha KHel, Shalman Area & Left-Over Villages of Bara Tribal District Khyber	320	June, 2022
	Electrification of Works at Arrang, Barrang, Charmang, Manogai, Salarzai & Mamund Area Tribal District Bajour	380	June, 2022
	Electrification of Works at Spinwam, Dosali & Razmak Area Tribal District North Waziristan	240	June, 2022
	Electrification of Works at Left Over Villages of Tribal Tehsil Tank	180	June, 2022
	Electrification of Works at Mulakhel, Alikhel, Khadizai, Mamozai, Sheikhan, DDM, Sepah, Manikhel, Goray, Chapri Feroz Khel, Gawak areas	500	June, 2022
	Electrification of Works at Central Kurram	270	June, 2022

ANNEX-C TESCO Investment Profile

128 To strengthen the authenticity of the Merged Areas, including Bajaur, Mohmand, Khyber, Orakzai, Khurram, North Waziristan and South Waziristan. The research team formulated a questionnaire, and the UNDP field staff conducted the survey. It was expected that survey results will provide credence to the picture evolved through consultations with the stakeholders. Survey was designed to develop a deeper understanding of all the energy resources including grid connectivity, solar solutions, biomass, coal, candles, LPG, and kerosene etc. Additionally, the survey exercise was also focused on understanding the willingness or people and their capacity to pay. Lastly, the major focus of the survey was to map out the use cases of people living in different settlements. This is a small effort within this diagnostic and should not be construed as a full-fledged data driven, analytical survey exercise by the readers.

Scope of Survey

129 Diagnostic survey was targeted to diverse entities like household, school, hospital, and commercial areas to get a better and more comprehensive insight of the baseline situation. Sample selection of survey was based on convenience sampling, in view of security challenges existing in NMDs. To make it a representative sample, all the 7 districts and 19 sub-divisions are covered with total of 200 interviews. Ensuring gender sensitivity of the study the survey sample was designed to get maximum input from women. Female enumerators were also brought on-board to attain maximum input. However, due to social restrictions and dynamics of the area, only 25 interviews were directed to females out of total 200 interviews. To maintain the quality of field data collection, experienced enumerators were involved from each district. A virtual training session was also held for all the enumerators to better understand the questionnaire and remove any ambiguities, if any.

Methodology

130 To make it an evidence based diagnostic study, a survey has designed to investigate all the possible sources of electricity supply available to the residents of the Merged Areas and their consumption pattern for energy as well. Data has been collected from all the districts including Bajaur, Mohmand, Khyber, Orakzai, Kurram, North Waziristan and South Waziristan for a better representation.

131 The primary objectives of this survey were as follows:

1. To develop a better understanding of all the sources available to the people of the Merged Areas for getting the supply of electricity (or energy) at various places including households, schools, commercial areas etc. Sources have explicitly divided into three broad categories,

- On-grid electricity supply.
- Off-grid solutions.
- Use of traditional biomass, charcoal or coal, candles, LPG (liquefied petroleum gas), kerosene etc.

1. To understand whether there exist any practice of bill payment against the supply from the grid and in order to improve the recoveries is there any willingness to pay for an improved and continuous supply in the future.

- 2. To identify the major uses of the electricity/energy in those districts.

3. To comprehend the concerns of all the stakeholders towards the expected future price rises in energy.

Sample Selection

132 Data has been collected from a variety of respondents to get a better insight of the on-ground situation. Primarily the entities include households, schools, hospitals, and commercial areas but to incorporate more diversity it was left to the enumerator to visit other places as well that were easily accessible. In terms of the other entities data has enumerated from Madrassa, political figures, petrol pump etc. Convenience sampling has done keeping in view the challenge of accessibility and security in these districts.

133 To make it a representative sample, data has been gathered from all the 7 districts. As highlighted in Table 8, ideally the target was to conduct 10 interviews from each sub-division which makes it a total of 190 interviews from all the districts. Composition of the sample is given below:

Table 8: Sample size

District	Sub-divison	Place of interview					
		Household	Commercial area	Hospital	School	Others	Total
Bajaur	Khaar	2	2	2	2	2	10
	Nawagai	2	2	2	2	2	10
Mohmand	Lower Mohmand	2	2	2	2	2	10
	Upper Mohmand	2	2	2	2	2	10
	Baizai	2	2	2	2	2	10
Khyber	Jamrud	2	2	2	2	2	10
	Landi Kotal	2	2	2	2	2	10
	Bara	2	2	2	2	2	10
Orakzai	Lower Orakzai	2	2	2	2	2	10
	Upper Orakzai	2	2	2	2	2	10
Kurram	Lower Kurram	2	2	2	2	2	10
	Central Kurram	2	2	2	2	2	10
	Upper Kurram	2	2	2	2	2	10
North Waziristan	Mirali	2	2	2	2	2	10
	Miramshah	2	2	2	2	2	10
	Razmak	2	2	2	2	2	10
South Waziristan	Ladha	2	2	2	2	2	10
	Sarwakai	2	2	2	2	2	10
	Wanna	2	2	2	2	2	10
	Total	**38**	38	**38**	**38**	**38**	**190**

TAs per the enumerated data, 83.96% (178 out of 212) of the originally planned sample has been covered. [134] However due to the 22 extra interviews conducted in different sub-divisions, the total number has exceeded the original target making it a total of 200 interviews. Specifically, in case of Lower Orakzai, security situation was not favourable in many parts therefore a prominent imbalance in the composition of approached entities can be observed.

Findings

Under this section, results are presented related to the on-grid and off-grid supply of electricity to the residents of the Merged Areas, and their consumption pattern specific to the energy.

On-Grid Supply of Electricity

On-grid electricity is generally considered as a primary source of supply therefore, all the respondents were asked if they have access to the electricity provided by WAPDA. Out of the total respondents, 82.50% (165 out of 200) mentioned that they are connected to the grid. District wise distribution reveals that 100% (30 out of 30) of the responses from Kurram indicated the association with the grid supply which is highest percentage compared to the other districts whereas only 56.67% (17 out of 30) of the respondent from South Waziristan told to have the access to the grid electricity which is the lowest of all (please see Table 9). [135]

Table 9: Number of respondents who have access to grid electricity (per district)

Name of the district	Did you have access to the grid electricity provided by WAPDA?		
	No	Yes	Total
Bajaur	4	16	20
Mohmand	6	26	32
Khyber	1	29	30
Orakzai	8	12	20
Kurram	0	30	30
North Waziristan	3	35	38
South Waziristan	13	17	30
Total	35	165	200

136 Segregating the data in terms of different entities (household, commercial area, school, hospital etc.) unveils that the most electrified among all are the commercial areas where 90.24% respondents have the access to the grid electricity on the other hand schools are the least electrified (68.42%) (please see Figure 15).

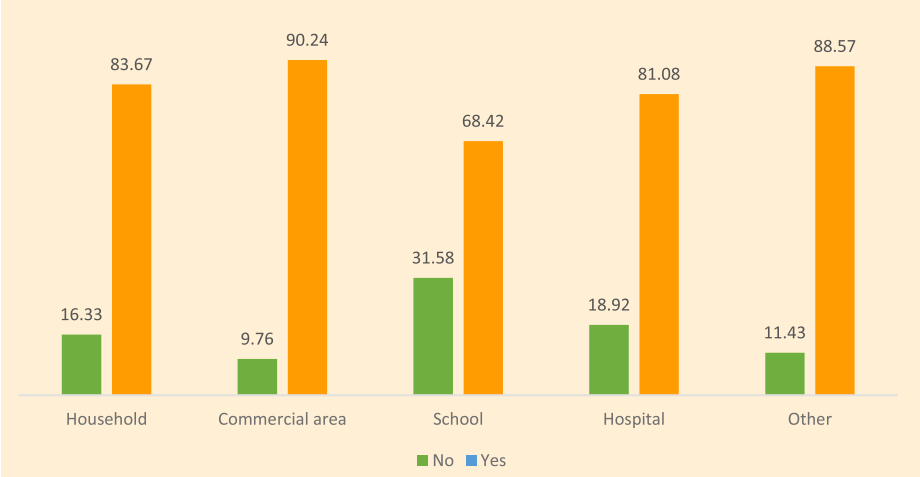

Figure 15: Percentage of respondents who have access to grid electricity (per entity)

137 Although a majority of the respondents were connected to the grid, but the average duration of electricity supply reported by most of them ranges between 2-5 hours approximately in a day. As provided in Table 10, the highest average has been reported in Orakzai (4.909 hours) whereas Mohmand (2.096 hours) is getting the supply for lowest number of urs compared to the other districts.

Table 10: Average number of hours for which the electricity has been provided (per districts)

Name of the district	Number of responses	Average number of hours
Bajaur	20	3.333
Mohmand	32	2.096
Khyber	30	4.556
Orakzai	20	4.909
Kurram	30	3.3
North Waziristan	38	3.457
South Waziristan	30	3.533

Along with the comprehension of supply pattern, it was also important to understand the recovery rate among these districts therefore respondents were asked whether they pay a bill against the use of grid electricity. Out of all, 90.3% (149 out of 165) said that they have never submitted any amount. Although situation in all the districts is not pleasant but in case of Kurram (96.67%) and Orakzai (100%), approximately all the respondents never paid anything (please see Table 11). 138

Table 11: Number of respondents who pay bill (per district)

Name of the district	Do you pay a bill every month?		
	No	Yes	Total
Bajaur	13	3	16
Mohmand	22	4	26
Khyber	27	2	29
Orakzai	12	0	12
Kurram	29	1	30
North Waziristan	31	4	35
South WaziristanTotal	15	2	17
Total	149	16	165

During the initial consultations with various public and private stakeholders, a perception about the people of the Merged Areas had emerged that they are willing to pay bills if there will be a continuous supply. Therefore, in order to deal with the issue of poor recoveries, people were asked whether they will pay the bill if there is an uninterrupted supply. Among all, 80.41% (119 out of 148) of the respondents agreed to this idea (please see Table 12). 139

Table 12: Number of respondents who are willing to pay bill if there is a continuous supply of electricity (per district)

Name of the district	Are you willing to pay the bill if there is a continuous supply of electricity?		
	No	Yes	Total
Bajaur	7	6	13
Mohmand	8	14	22
Khyber	6	21	27
Orakzai	2	10	12
Kurram	2	26	28
North Waziristan	4	27	31
South WaziristanTotal	0	15	15
Total	29	119	148

But for the current supply which is merely 2-5 hours on average (as mentioned in Table 5) being provided to the people of the Merged Areas, 66.67% (98 out of 147) among the total respondents don't believe to be charged a cost recovery tariff against this supply. An extremely strong resentment has seen from Bajaur (91.67%) and Kurram (96.43%) district, where almost all the respondents refuse the idea of imposing a tariff (please see Table 13). 140

Table 13: Number of respondents who believe to have a cost recovery tariff for the electricity being provided (per district)

Name of the district	People should be charged a cost recovery tariff for electricity being provided?		
	No	Yes	Total
Bajaur	11	1	12
Mohmand	16	6	22
Khyber	14	13	27
Orakzai	7	5	12
Kurram	27	1	28
North Waziristan	20	11	31
South WaziristanTotal	3	12	15
Total	98	49	147

Off-grid solutions

141 No matter whether an area has a grid supply there is still a chance that people optimize their energy consumption by adding more sources to the list. Especially in case of Merged Areas where the supply of grid electricity is already insufficient, a strong dependency on off-grid solution to meet the need is not surprising. Hence all the respondents were given some options to choose from and 73% (146 out of 200) of them reported to have solar (PV) system as an alternative to the grid electricity. Second most reported substitute is electric generator which has been used by 23% (46 out of 200) of the respondents (please see Table 14).

Table 14: Number and percentage of the respondents using various off-grid sources (multi-select)

Do you get electricity from the below mentioned sources?	Frequency	Percentage
GENSET electricity (from neighbour/ relative)	6	3
Micro-grid in the community	18	9
Solar (PV) home system	146	73
Owned electric generator	46	23
None of the above	28	14

142 If we see the district wise distribution of the responses that highlight the use of solar (PV) system, it reveals that Kurram (17.81%) and North Waziristan (17.81%) has the highest percentage of reported cases followed by South Waziristan (17.12%) and Khyber (16.44%).

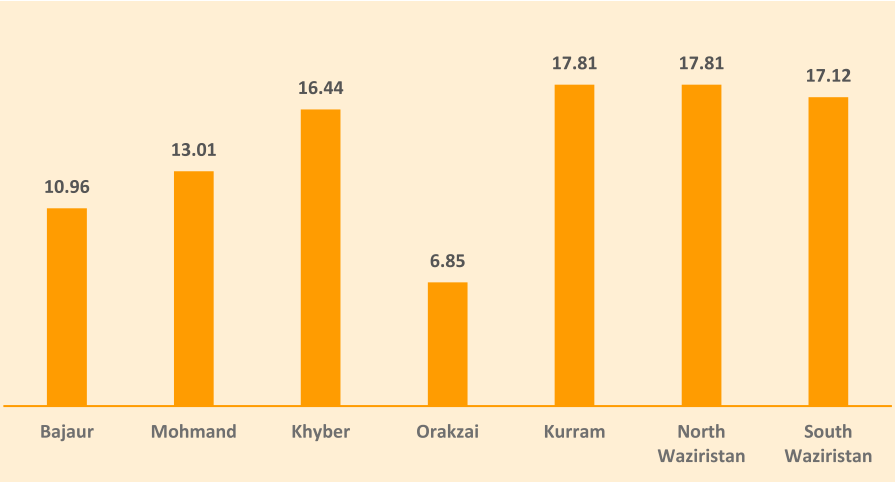

Figure 16: Percentage of respondents who use solar power as primary source

143 To meet the need of energy people often rely on some other sources as well like firewood, coal, kerosene, diesel etc. Therefore, respondents were given a list of the substitutes provided in Table 15 to observe their consumption pattern. Results suggest that, 42% of the total respondents reported the use of LPG (liquefied petroleum gas) whereas in most cases (31%) people were also inclined to use agriculture residue, dung, firewood and other traditional biomass followed by coal or charcoal (15.5%). However, 18.5% of the respondents mentioned that they do not use any alternatives among the list.

Table 15: Number and percentage of the respondents using various other sources for energy (multi

During th last 30 days have you used the following items listed below?	**Frequency**	**Percentage**
Agricultural residue/ Dung/ Firewood/ other traditional biomass	62	31
Charcoal or coal	31	15.5
Candles	9	4.5
LPG (liquefied petroleum gas)	84	42
Kerosene	6	3
Diesel	28	14
Natural Gas	28	14
None of the above	37	18.5

Uses of electricity

Earlier discussion reveals that people do have a strong reliance on various sources for getting the energy therefore it is also important to understand its utilizing for different purposes. 144

Table 16: Sources for which electricity/energy has been used (multi-select)

What is electricity used for?	Frequency	Percentage
TV/Radio	48	22
Video/DVD	14	7
Fans	163	81.5
Electric iron	62	31
Refrigerator	87	43.5
Cooking	31	15.5
Electric hot plate or stove	14	7
Improved cooking stove	3	1.5
LPG burner or stove	7	3.5
Kerosene lamp	2	1
Water heating (for washing/bathing)	78	39
Space heating	25	12.5
Water pumping	98	49
Lights	33	16.5
Phone charging	10	5
Medical equipment	7	3.5
Other small appliances	102	51
Other (specify)	7	3.5

As given in the Table 16, among all the respondents 81.5% use the energy to turn on the fans followed by other small appliances (51%), water pumping (49%), refrigerator (43.5%) and water heating for washing/bathing (39%). Since people rely more on off-grid solutions therefore this pattern for energy consumption seems logical. 145

Effect of inflation

Lastly, people were asked about their perception for the expected future price rise in energy. 60% (120 out of 200) of them were worried to a great extend while 25% (50 out of 120) were concerned to a fair amount. On the other hand, 12% (24 out of 120) were not very much anxious for any change in the prices. 146

Table 17: Number of people who gave a response against the expected future price rise in energy

Name of the district	How concerned are you about the expected future price rises in energy?				
	A lot	A fair amount	Not very much	Not at all	Total
Bajaur	17	2	0	1	20
Mohmand	23	9	0	0	32
Khyber	12	11	4	3	30
Orakzai	14	5	1	0	20
Kurram	10	5	13	2	30
North Waziristan	18	14	6	0	38
South Waziristan	26	4	0	2	30
Total	120	50	24	6	200

ANNEX-D Literature Review

147 Globally, rural electrification topography similar to the MAs is being addressed by two major solutions: Mini-Grids and Solar Home Systems (SHS). SHS are limited up to 50 kW while the mini grids can provide from 10kW to 10 MW of power for area and are more suitable for community or village level. It has been found that for an 'average 500-household village in sub-Saharan Africa' with 5 kWh/month consumption, mini grids became cost-advantageous over grid extension when the distance from the grid exceeded 4 km . According to International Energy Agency (IEA), 70 percent of unserved rural areas can be electrified through off-grid solutions out of which 65 percent can be powered through mini-grid and 35 percent can be powered through SHS . The optimum solution for any rural area, depends largely upon the use case of the end consumer along with several other factors. The Multi-Tier Framework (MTF) developed by Energy Sector Management Assistance Program (ESMAP) and Sustainable Energy for All (SEforAll) categorizes the varying levels of access to productive uses of energy, from Tier 0 (no access) to Tier 1 (light and phone-charging), Tier 2 (adding TV and fan), Tier 3 (adding medium-power appliances such as refrigerators and water pumps), Tier 4 (adding high-power appliances such washing machines and irons) to Tier 5 (adding very high-power appliances such as vacuum cleaners, water heaters and air conditioners) . For better understanding, the overall literature review tends to focus on learning outcomes from rural electrification; learnings from both off-grid and on-grid electrification.

Challenges of Access to Electricity

148 The energy access problem has a distinct regional and international dimension with lack of access to electricity being most prevalent in Sub-Saharan Africa and Developing Asia. Around 585 million people in Sub-Saharan Africa lack access to electricity while 675 million in Developing Asia face the same problem . Further, energy access quality is predominantly a rural problem. Globally, 1.1 billion (out of 1.3 billion) lacking access to electricity live in rural areas. Similarly, more than 2.2 billion (out of 2.7 billion), lacking access to clean cooking energy, reside in rural areas (IEA 2011). In the African landscape, Mali is often cited as the country that has had most success in developing isolated mini grids, that too driven by the challenge of absence of national grid . The economics of mini-grid development in Sub-Saharan Africa are challenging, just like MAs in Pakistan, given the remote locations, limited ability-to-pay of customers, limited load factors, and generally low electricity consumption. This makes SHS another viable option that has been largely penetrated through private market players and international donor agencies. To understand the challenges related to rural electrification, an overarching review of global case studies, in particular countries with similar rural electrification condition is presented. Among these the African and Latin American countries show similar scenarios to MAs with highly limited or no access to grid for most of the rural areas.

Sierra Leone – Ease in Regulatory Governance

149 National electrification rate for Sierra Leone stands at about 13 percent, with one-third of population living in rural areas completely deprived of basic facilities including provision of electricity . The Government of Sierra Leon (GoSL) planned to provide cost effective electricity to 60 percent of remote areas location with no connectivity to grid. Most of these Mini-Grids developments were dependent on GoSL and donor agencies whereas the participation of private sector remained limited. In efforts to build enabling institutional capacity for rural electrification, Mini-Grids regulations were developed in 2018 that supports efficient and swift licensing arrangements and tariff structure. The regulations set 30-day time limit for reviewing and license issuance, to speed up the process. The process started when GoSL Electrification Authority envisaged electricity sector reform roadmap that could help build capacity, improve efficiency, and attract finances. A study was conducted by GoSL and other international partners based on field surveys which gave some useful insights to rural electrification:

- The optimized pathway for rural electrification varies largely based on use cases and dynamics of the area. Hence, there is no single fit solution for all rural areas. Consumer demand and its corresponding tier of access should determine type of technology involved in electrification.
- Mini-Grids and SHS provide an immediate solution while the grid expansion remains a viable option in the longer term. If high power appliances such as A/Cs, vacuum cleaners, washing machines, and irons are also prospective use cases, then Mini-Grids or grid connections are required in longer term. Otherwise, lower tier loads can be cost-effectively fulfilled by SHS.
- Mini-Grids require large cumulative load to overcome the cost of wiring and meters. These costs are lower in SHS. Areas with higher load density (per unit area) require less Low-voltage Transmission (LT) line materials and labor for installation which reduce distribution cost and, in turn, favor Mini-Grids development.

Nepal – Community Electricity Distribution

150 Only 32 percent of rural Nepalese have electricity in their homes, that too is accompanied by high load shedding. The institutional structure of electricity market in Nepal follows a top-down approach with a central regulatory authority known as Nepal Electricity Authority (NEA). However, the authority's limited capacity paved space for

community led grid extensions that opened avenues for off-grid electrification. The grid of Nepal is mostly reliant on hydro power, and hence this creates issues pertaining to load shedding in the dry season. To overcome rural electrification, Community Electricity Distribution by laws were adopted that enabled rural groups to buy and retail electricity. Based on these regulations, communities share 20 percent of total cost for grid expansion . The cost can be paid in terms of labor, household donations, bank loans and grants from local or district development committees that are also responsible for any theft occurring in that distribution area, which proved to be a successful model.

Kenya – Combining Private Sector Expertise with TELCOs

151 Only 10 percent of rural Kenyans have access to electricity in their homes, with the major issue being the affordability associated with cost of electrification. The electrification plans for Kenya include mostly government led grid expansions with limited focus on off grid electrification. Most of the off grid solar projects are spear headed by the private sector. Like Nepal, Kenyan grid is mostly reliant on hydro power, creating issues pertaining to load shedding in the dry season. Moreover, the weak transmission and distribution system has exacerbated financial problems for energy sector. To speed up rural electrification, a Rural Electrification Authority (REA) was established in 2007 which was mainly focused on grid expansion activities, as 75 percent of the country's population is concentrated in 10 percent of its landmass. REA established a master plan detailing its intention to electrify 40 percent of rural households by 2020. In addition to developing off-grid systems in 200 localities, REA ran small number of pilot projects for off-grid renewable energy including biogas and biomass gasification. On SHS side, the market had overwhelming private participants with an estimated 300,000 SHS. The robustness of private market is evident form nexus built between different sectors, like telecommunication companies, which have installed hybrid wind-solar-diesel generation systems for off grid base stations while providing a charging point for locals to recharge their mobile telephones free of charge. Such innovative economy model could offer a potential solution to unelectrified areas like Mas.

China – A Multi-Modal and Multi-Resource Approach

152 China has assumed a multi-mode delivery system with reliance on no one method or technology. Unlike most developing countries where the grid extension has been the preferred, China has experimented with alternative strategies. Pan et al. (2006) report that rural electrification relied on three modes of delivery: local grid-based, central-grid based and a hybrid system of local and centralized grids. Local grids with large hydro potential areas have been responsible for electricity supply. However, the dominant mode of supply remains the extension of central grid but due to high cost of distribution, rural consumers either face shortages or were unable to afford electricity from the grid. The third mode (i.e., a hybrid system) is used in areas where hydropower is inadequately available to meet local demand and where local, off-grid methods were used depending on the geography and the topography.

India – Rural Electrification, a Political Priority

153 During the last decade, rural electrification has come become a political priority in India, with the Government of India creating the necessary enabling environment through the REST (Rural Electricity Supply Technology) Mission in 2001, Electricity Act 2003, National Electrification Policy 2005, and Rural Electrification Policy 2006. The government has already declared the objective of 'power for all' under the REST Mission and continued it with the launch of a large-scale electrification effort, the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) scheme to create access to electricity for all households and provide connections to 32 million BPL (Below Poverty Line) households.

154 However, (Palit and Chaurey 2013) contended that the RGGVY may have achieved its targets of village electrification; the overall household electrification level has not increased substantially. While 87 percent of the targeted villages had been energized, studies indicate only about 20 percent of the total un-electrified rural households have taken connection (Palit and Chaurey 2011). This is largely because of the ambiguity in interpreting the term "electricity access". As part of RGGVY, the government contends that access has been created and now the onus of taking the connection rests with individual households. A top-down approach, funnelled through the Federal Government, has proved to be lacking the on-ground knowledge to execute projects in both letter and spirit.

Bangladesh – Relying on Rural Electricity Cooperatives

155 Bangladesh has relied upon the Rural Electrification Board (REB) to extend electricity to rural areas by forming five rural electricity cooperatives known as "Palli Bidyut Samities" (PBSs). The REB has divested the distribution of power to end-users through PBSs to ensure local ownership and participation (Krithika and Palit, 2011). Each PBS is responsible for providing grid extension to 5–6 districts. PBSs are independently and privately owned, yet they remain under the direct regulatory control of the REB, which manages the procurement process, financial sustainability, and management effectiveness (Cruickshank and Yadoo 2010). The REB regulates the PBSs and envisages providing financial and operational autonomy once the PBSs become profitable and self-sufficient.

156 There are strict controls in place and the REB instils a strict discipline into the process through comprehensive training (Rejikumar 2007). The REB can terminate employment with the PBS board approval for non-performance. The most important feature of the model is the annual performance target which the PBSs must sign with REB, covering 22 parameters broadly committing to increase revenues and connections, decrease losses and improve service quality, based on previous year's achievements. Overall, PBSs have been claimed to be successful as they have been able to achieve 14.31 percent distribution losses as compared to the national average of 30–35 percent losses, 97 percent collection efficiency, as reported by Krithika and Palit in 2011.

Pakistan – SHS deployment in Bajaur Agency

157 Solar energy can be properly utilized for people residing in MAs where the supply and maintenance of national grid electricity can prove to be cost intensive. Subsequently, the regions under the national grid are subjected to unreliable and inconsistent energy. Hence, renewables could be the most cost-effective short-term solution for MAs. A study was conducted in which stand-alone SHS were given to a village in Bajaur agency named Lakiyanu. The Lakiyanu village was equipped with a solar system under the RLCIP (Rural Livelihood and Community Infrastructure Project) in December 2013. RLCIP is one of the multi-donor trust fund (MDTF) projects managed by the Department of Planning and Development (P&D) and funded by the World Bank Group (WBG). The SHS offered to households consisted of a 200-watt solar panel, along with a 12-volt power saver, a 200 Ah dry battery, an electric fan and a controller. The SHS was given to each household based on number of rooms, with one system per two rooms . The main postulates gauged from the case study including the impact of solar energy on the lives of the respondents are following:

- The results showed that consumption of energy resources used for cooking such as wood, dung cakes and waste crops remained the same after installation of the SHS, while consumption of LPG decreased from 4.5 kg to 3.2 kg per month. The other energy resources used for lightning, such as kerosene oil, have been fully replaced.
- The analysis showed an increase in children's research and study hours. According to the parents, earlier it was difficult for their children to carry out their homework at night.
- The SHS resulted in an improvement in the physical capital based on the results of the households surveyed. The SHS consisted of solar panels, batteries, lamps, and fans. Moreover, people started using communication device like cell phones due to provision of SHS systems. Very few people used cell phones before the project as they had to pay Rs. 10 for charging their cell phones in nearby markets.

Best Practices in Rural Electricity Access

158 There are few models and best practices which have stood out among the literature review, providing viable way forward and best practice approaches. For instance, China and Bangladesh's models have worked very well for their general population, mostly relying on distributive, multi-modal and participatory approaches whereas countries like India, sub-Sahara Africa and Pakistan have not worked very well with their top-down approaches. Number of key lessons learnt, and their summaries are identified below:

- Government's strong commitment to rural electrification is required. China, Bangladesh, and Sierra Leone have demonstrated a strong commitment from the federal and provincial governments with clearly laid out plans for rural electrification. This is true for any country who aspires to bank on an ambitious program with a strong government and stakeholder commitment. The key success factor in the case of China was the strong central government commitment to rural electrification.
- Active local participation remains the key. A top-down approach has not generally worked in countries opting to push for rural electrification agenda. In the case of MAs, for instance, a centralized distribution company TESCO is in charge with no clear mandate to provide electricity considering on-ground local participation. There are no concrete financial plans and robust subsidy practices, which consequently results in sub-par operational performance. As opposed to this approach, rural electrification schemes work better when they are implemented through local participation, such as in the cases of China and Bangladesh. This however requires a strong local level governance mechanism that has close links with other levels of the governance.
- Consumer focused rural electrification schemes. Case studies of China and Bangladesh have been successful as they do not have one-size fits all solution. Programs have been designed based on characteristics in terms of resources, economic activities, geography, and topography. Although grid extension has been widely used in China, they have also relied on multiple technologies and multiple systems. In the case of China, micro-hydel were also used at the community levels and with falling prices of solar, the focus has shifted to SHS deployment to far-flung remote areas. The key has always been to keep consumer priorities upfront and to provide them localized, financially viable and fiscally responsible schemes, geared towards long-term human development.
- Need to create strong nexus of employment opportunities. Electricity cannot be divorced from the rural development agenda. The development of agriculture and TVE confirms that only when rural population has access to economic activities to earn a decent living, rural electrification succeeds. This re-joins the issue of proper selection and clustering of activities in each area or community, considering its specific characteristics.

ANNEX-E Review of Policies, Legislations and Review

Policies

(i) Petroleum Policy (2012), amended 2019
(ii) Tight Gas Policy 2011
(iii) Low Btu Gas Policy 2012
(iv) Marginal/Stranded Gas Policy
(v) Liquified Natural Gas Policy 2012
(vi) Liquified Petroleum Gas (Production and Distribution) Policy 2016
(vii) NEPRA Act Amendment 2019
(viii) National Power Policy 2013
(ix) Power Generation Policy 2015
(x) Policy Framework of Private Sector Power Transmission Lines (2015)
(xi) KP Hydel Power Development Policy 2016

Relevant legislation and documents

(i) Guidelines to KP Hydel Power Policy
(ii) Regulation of Power Generation, Transmission and Distribution of Electric Power (Amendment) Act of 1997 (November 2017) – NEPRA Act
(iii) Framework for Power Cogeneration 2013 Bagasse and Biomass
(iv) National Energy Efficiency and Conservation Act (2016)
(v) NEPRA (Interconnection for Renewable Generation Facilities) Regulations, 2015
(vi) NEPRA (Wheeling of Electric Power) Regulations, 2016
(vii) Amendments in "NEPRA (Alternative & Renewable Energy) Distributed Generation and Net Metering Regulations, 2015" (Notification (S.R.O.1025 (I)/2017 dated 10-10-2017
(viii) Amendments in the National Electric Power Regulatory Authority (Alternative & Renewable Energy) Distributed Generation and Net Metering Regulations 2015. (Notification (S.R.O.1261 (J)/2017 dated 20-12-2017)
(ix) NEPRA (Alternative & Renewable Energy) Distributed Generation and Net Metering Regulations, 2015
(x) NEPRA (Sale of Electric Power by Renewable Energy Companies) Guidelines, 2015
(xi) KP medium-term growth strategy
(xii) NEPRA State of the Industry Report, 2020
(xiii) NEPRA TESCO End-Consumer Tariff Determinations 2013-2020

ANNEX-F List of Consultations

The following list summarizes status of stakeholder consultations:

Public Sector Stakeholders

1. Muhammad Zubair (Advisor Energy, KP)
2. Faiz Arbab (Chief Energy, Planning & Development KP)
3. Sajid Hussain Turi, Member NA (NA 46)
4. Muhammad Bakhtiar Khan (DG Sustainable Development Unit KP)
5. Muhammad Akram Mirza (CEO, TESCO)
6. Fazl-e-Rabi (Chief Planning Officer, TESCO)
7. Sajid Raees (DD Planning & Engineering, TESCO)
8. Shabab Hussain (AD Planning & Engineering, TESCO)
9. Sajjad Ahmed (HR Director, TESCO)
10. Sajjad (Finance Director, TESCO)
11. Syed Iqramullah shah (DD Operations, TESCO)
12. Mr. Bahadur Shah (Member KP, NEPRA)

Private Sector Stakeholders

1. Irshad Bhatti (Nizam Energy)
2. Muhammad Shehryar (MD, Harness Energy Pvt Ltd)
3. Shehryar Shakeel (Sales Manager, Trina Solar)
4. Faisal Naseer (Director, Catkin Engineering)
5. Abrar Khattak (PMIC)
6. Aijaz Ali (Indust Earth Trust)
7. Manzoor Karim (Manager Alliance, Khushali Microfinance Bank)
8. Maliha Khan (PR and Digital Executive, Khushali Microfinance Bank)
9. Vaqas Ataullah Butt (President, ACE Welfare foundation)
10. Oliver Knight, Saadia Qayyum and Maha Arshad (World Bank)
11. Zargham Eshaq Khan (MD, NESPAK)

References

Mininstry of Finance, G. o. (2020). *Budget in Brief* .

Unknown. (n.d.). *Federally Administered Tribal Areas* . Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Federally_Administered_Tribal_Areas

IRENA. (2017). *Rocky Mountain Institute (RMI) with other cost data and RMI cost modelling.*

IEA, I. E. (2016). *World Energy Outlook 2016 Electricity access database.* Retrieved from https://www.iea.org/reports/world-energy-outlook-2016

ESMAP, E. S. (2015). *MULTI-TIER FRAMEWORK FOR MEASURING ENERGY ACCESS.* Retrieved from SE4ALL: https://www.esmap.org/node/55526

PWC. (2016). *Electricity beyond the Grid : Accelrating access to sustainable Power for all.* Retrieved from https://www.pwc.com/gx/en/energy-utilities-mining/pdf/electricity-beyond-grid.pdf

Center, C. E. (2017). *Rural Electrification in Sierra Leone: The role of mini grids vis-a-vis Stand alone Home Systems and Mini grids.* Retrieved from https://ledsgp.org/wp-content/uploads/2019/07/SL_Briefing.pdf

IIED. (2012). *Delivery Models for Decentralized Rural Electrification.* Retrieved from https://pubs.iied.org/pdfs/16032IIED.pdf

Abdullah, Z. D. (2017). Acceptance and willingness to pay for solar home system: Survey evidence from northern area of Pakistan. *Energy Reports*.

PIDE, D. o. (2017). *Role of Solar Energy In Improving the Livelihood of Rural Households: A Case Study of Bajaur Agency.*

NTDC. (2019). *Power Market Survey* .

PESCO. (2019). *Annual Report.* Retrieved from PESO: http://www.pesco.gov.pk/notifications/finance/2019/audited-account-fy-2018-19.pdf

News, A. (n.d.). Retrieved from https://arynews.tv/en/kp-govt-launches-4-large-scale-development-projects-in-erstwhile-fata/

Hussain, A., & Batra, A. (2017). *An experimental study on effect of dust on power loss in solar photovoltaic module.*

Jacobson, M. Z., & Jadhav, V. (n.d.). *World estimates of PV optimal tilt angles and ratios of sunlight incident upon tilted and tracked PV panels relative to horizontal panels.*

Abbasi, A. (n.d.). *Self Sufficiency in Oil and Gas, Policy Brief 46 Ibid* .

PPIB. (2011). *Hydropower Resources of Pakistan.*

GoKP. (2019). *Sustainable Development Strrategy: A Mediium Term Framework for KP 2019-23.*

NEPRA. (2019). *State of the Industry Report 2019.*

GoP. (2018). *The Constitution of the Islamic republic of Pakistan.*

UNDP. (2017). *Pakistan National Human Developmemnt Report.*

NEPRA. (2020). *TESCO Distribution Tariff Determination for FY 2019-20.* Retrieved from NEPRA website: https://nepra.org.pk/tariff/Tariff/DISCOs/TESCO/TRF-498%20TESCO%20Determination%2014-12-2020%2045575-77.PDF

NEPRA. (2020). *State of the Industry Report.*

GoKP. (2020). Accelerated implementation Program, The beggineing of Tribal Development Decade.

GoP. (2017). *https://www.pbs.gov.pk/content/block-wise-provisional-summary-results-6th-population-housing-census-2017-january-03-2018.*

PEDO. (2020). *PEDO Website*. Retrieved from http://pedo.pk

Schnitzer, D. (2012). *Microgrids for Rural Electrification.* United Nations Foundation.

Kovandova, E. (2019). *Center for Development Alternatives*. Retrieved from https://cda.co.ug/2051/a-new-business-model-for-sustainable-rural-electrification/

Peters, J. (2009). *Evaluating Rural Electrification Projects.* Rural Economic Papers.

Lovins, A. (1976). *Energy Strategy: The Road Not Taken.* RMI.

WBG. (2021). *Variable Renewable Energy Integration and Planning Study* . WBG.